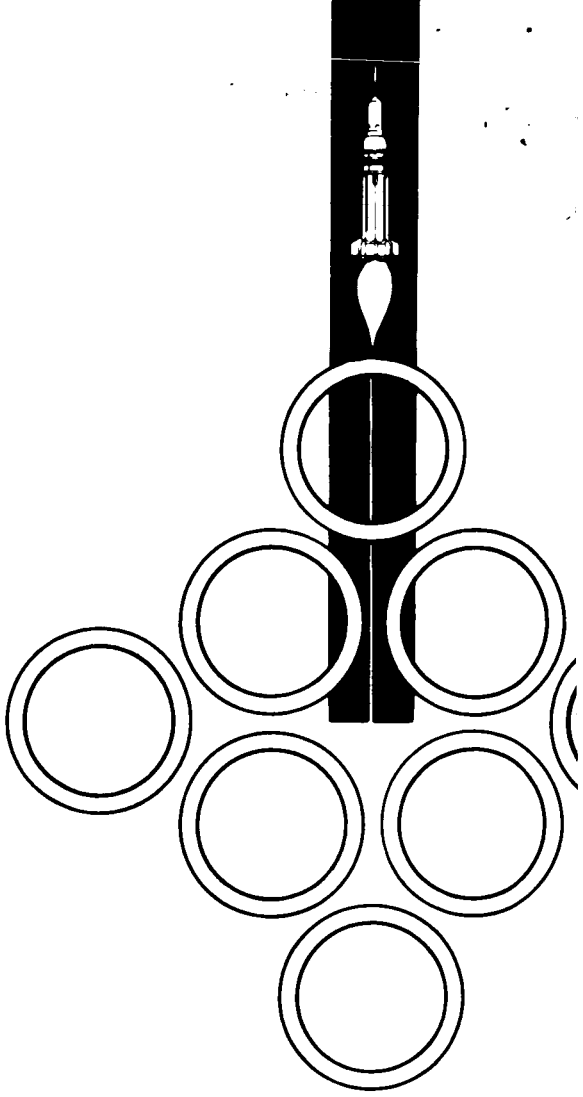

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LAUNCH VEHICLE SA-10 AND LAUNCH COMPLEX 37B FUNCTIONAL SYSTEMS DESCRIPTION

Volume II

LOX SYSTEM FUNCTIONAL DESCRIPTION,
INDEX OF FINDING NUMBERS,
AND MECHANICAL SCHEMATICS

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AND
LAUNCH COMPLEX 37B
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LOX SYSTEM FUNCTIONAL DESCRIPTION,
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August 1964

CHRYSLER CORPORATION SPACE DIVISION - NEW ORLEANS, LOUISIANA

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FOREWORD

This volume is one of a set of eleven volumes that describe mechanical and electro-mechanical systems of the Saturn I, SA-10 launch vehicle and launch complex 37B. The eleven-volume set is prepared for the Functional Integration Section, Systems Integration and Operations Branch, Vehicle Systems Division, P&VE Laboratory, MSFC, by Systems Engineering Branch, Chrysler Corporation Space Division under Contract NAS 8-4016. Volume titles are listed below:

Volume I	RP-1 Fuel System
Volume II	LOX System
Volume III	LH_2 Fuel System
Volume IV	Nitrogen and Helium Storage Facility
Volume V	Pneumatic Distribution System
Volume VI	Environmental Conditioning Systems
Volume VII	Launch Pad Accessories
Volume VIII	H-1 Engine and Hydraulic System
Volume IX	RL10A-3 Engine and Hydraulic System
Volume X	Separation and Flight Termination Systems
Volume XI	Supplement: Legend and Composite Schematic

The technical content of this volume reflects up-to-date design information available from the S-I/S-IB Project Engineer, R-P&VE on July 15, 1964.

System mechanical schematics are provided in section 3 to support the functional description of the system. The index of finding numbers in section 2 provides physical and functional descriptions of components identified on the mechanical schematics.

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SECTION 1

FUNCTIONAL DESCRIPTION

1.1 INTRODUCTION

The Saturn I launch vehicle SA-10 and launch complex 37B LOX system, as described in this volume, includes launch complex equipment involved in supplying LOX to the S-I and S-IV stages, and launch vehicle equipment that stores LOX and supplies it to the S-I and S-IV stage propulsion systems during vehicle flight.

Figure 1-1 identifies system equipment with respect to both location and functional subsystem arrangement. Specifically excluded are one-shot safety devices, such as burst diaphragms, and subsystems or components used exclusively for maintenance of launch complex equipment.

This functional description is predicated on an abort-free countdown, launch, and vehicle flight, and further assumes that both the launch complex and the launch vehicle are in a state of readiness for initiation of the prelaunch countdown.

1.2 SYSTEM FUNCTIONS

The functions of the LOX system are: (1) the storage of LOX for filling the S-I stage and the S-IV stage LOX tanks, (2) the controlled transfer of predetermined quantities of LOX to the S-I stage and S-IV stage LOX tanks, and (3) the in-flight supply of LOX to the S-I stage and S-IV stage propulsion systems. The system operations involved in the accomplishment of these functions are identified and briefly described in the following paragraphs.

1.2.1 LOX Storage - LOX is brought to the launch complex in service trailers and is transferred to the main and replenish storage tanks in the LOX storage facility. However before LOX is pumped into the tanks, both tanks are purged, the annular space between the walls of the main storage tank is pressurized, and the annular space between the walls of the replenish tank is evacuated. LOX remains in the tanks until transferred to the launch vehicle during LOX transfer operations.

1.2.2 LOX Transfer - LOX transfer between the LOX storage facility and the S-I and S-IV stages is accomplished through cross-country transfer lines that link the storage facility with the vehicle launcher and umbilical tower. During LOX loading operations, these lines carry LOX to the launch vehicle. When a launch cancellation necessitates the draining of vehicle LOX tanks, the lines carry LOX from the vehicle to the storage facility. LOX transfer to and from the S-I stage and S-IV stage is accomplished through separate transfer lines, but the operations involved are performed in a coordinated sequence. The operations are initiated, controlled, and monitored by LOX control equipment located in the launch control center (LCC) and the automatic ground control station (AGCS).

1.2.2.1 Main and Replenish Storage Tank Pressurization. First in the sequence of transfer operation is the pressurization of the main and replenish storage tanks. The two storage tanks are pressurized with gaseous oxygen (GOX) to reduce LOX boiloff and to aid in transferring LOX to the launcher area. Pressurizing GOX is converted from LOX in two vaporizers, one for each storage tank.

1.2.2.2 S-I Stage LOX Transfer. S-I Stage LOX transfer includes transfer line precool, main fill, replenish line precool. S-I stage LOX bubbling, replenish, and S-I stage LOX tank pressurization.

a. Transfer Line Precool. LOX flows from the main storage tank through the S-I stage main fill and drain line into the S-I stage LOX tanks. This initial flow precools the transfer line and components to reduce in-line vaporization during main fill. The formation of GOX in the transfer line through vaporization would impede the transfer of LOX. If the vaporization rate were excessive, the resultant pressure build-up could rupture the transfer line.

b. Main Fill. LOX is pumped from the main storage tank to the S-I stage LOX tanks at 2500 gpm. The main fill operation is continued until the stage LOX tanks contain 95 percent of a predetermined mass.

c. Replenish Line Precool. LOX flows from the replenish storage tank to the S-I stage LOX tanks to precool the replenish line. Precooling is initiated when the S-I stage LOX tanks have been filled to within 75 percent of the predetermined mass and is terminated when the tanks are 95 percent filled. Precooling during the main fill operation permits immediate initiation of the replenish operation upon termination of the main fill operation.

d. S-I Stage LOX Bubbling. Helium is bubbled through LOX in the S-I stage tanks to prevent temperature stratification within the tanks and suction lines that supply LOX to the S-I stage propulsion system.

e. Replenish. LOX flows from the replenish storage tank, through the replenish line, and into the S-I stage LOX tanks to complete the filling of the tanks and to compensate for boiloff losses. A computer-controlled regulator valve admits LOX to the tanks at a given flow rate until the tanks are 100 percent filled and then reduces the flow to exactly compensate for boiloff losses.

f. Drain. The main and replenish storage tanks are depressurized and LOX is allowed to flow from the S-I stage LOX tanks back to the two storage tanks. This operation is not part of a normal countdown and is only performed when a launch cancellation necessitates draining the S-I stage LOX tanks.

g. S-I Stage LOX Tank Pressurization. Approximately 100 seconds before S-I stage engine ignition, the LOX bubbling and replenish operations are terminated and the S-I stage LOX tanks are pressurized to provide the proper LOX input pressure to the engines. The pressurization medium is helium supplied from a ground source.

1.2.2.3 S-IV Stage LOX Transfer. The operations involved in transferring LOX to and from the S-IV stage LOX tanks are: fill line precool, fill, LOX bubbling, replenish line precool, replenish, LOX tank pressurization, and final topping. Brief descriptions of the operations are given below.

a. Fill Line Precool. LOX flows from the main storage tank through the S-IV stage fill line and into the S-IV stage LOX tank. The LOX flow precools the fill line and components to reduce LOX vaporization during the fill operation.

b. Fill. LOX is pumped from the main storage tank and transferred to the S-IV stage LOX tank at 1000 gpm. The fill operation is continued until the S-IV stage tank contains 98 percent of a predetermined LOX mass.

c. LOX Bubbling. Helium from a ground source is bubbled through LOX in the S-IV stage LOX tank to prevent temperature stratification within the tank and the suction lines that carry LOX from the tank to the S-IV stage propulsion system. The bubbling operation is initiated approximately 12.5 minutes before ignition of S-I stage engines and is continued for approximately 10 minutes.

d. Replenish Line Precool. LOX flows from the replenish storage tank through the S-IV stage replenish line and is discharged into the launch facility dump pond. The LOX flow precools the line to reduce LOX vaporization during the replenish operation.

e. Replenish. LOX is transferred from the replenish storage tank to the S-IV stage LOX tank to compensate for boiloff losses and maintain the S-IV stage LOX tank level between 99.25 and 99.75 percent full with respect to a predetermined mass. During this operation, a computer-controlled throttle valve admits LOX to the S-IV stage LOX tank at two flow rates. The lower flow rate does not supply LOX sufficient to compensate for boiloff losses and is maintained until the LOX tank level falls to the 99.25-percent-full level. At this tank level, LOX is admitted to the tank at the higher flow rate until the tank is 99.75 percent full. LOX flow is again reduced to the lower flow rate until LOX depletion reduces the tank level to the 99.25-percent-full level. This alternation between two replenish flow rates is continued until approximately 150 seconds before S-I stage engine ignition. At this time, the tanks are filled to the 100-percent-full level.

f. S-IV Stage LOX Tank Pressurization. Approximately 150 seconds prior to S-I stage engine ignition, the S-IV stage LOX tank is pressurized for flight with helium supplied from the launcher complex.

g. Final Topping. At the start of LOX container pressurization, LOX is added to the S-IV stage LOX tank through the S-IV stage LOX replenish line to raise the tank level from 99.75 percent full to 100 percent full.

h. Drain. LOX is drained from the S-IV stage LOX tank and transferred back to the LOX storage facility. This operation is not part of a normal count-

down sequence and is performed only when a launch cancellation necessitates draining LOX from the launch vehicle.

1.2.3 S-I Stage Propulsion System Supply - LOX supply to the S-I stage propulsion system involves equal distribution of LOX to eight engines, in-flight pressurization of S-I stage LOX tanks, and engine cutoff operations. LOX consumption in the S-I stage begins with the ignition of the S-I stage engines.

1.2.3.1 LOX Distribution. The eight S-I stage engines receive equal amounts of LOX through individual suction lines that carry LOX from the tanks to the engine turbopumps.

1.2.3.2 LOX Tank Pressurization. Part of the LOX distributed to each engine is routed into the engine heat exchanger, where it is converted to GOX. The LOX tank pressurization subsystem uses the GOX as a pressurization medium and controls LOX tank pressure to maintain the proper LOX input pressure to each engine and to maintain the structural integrity of the tanks.

1.2.3.3 Engine Cutoff. A shutoff valve in each LOX suction line terminates the engine LOX supply in the event of engine malfunction or a programmed shutdown of the engine.

1.2.4 S-IV Stage Propulsion System Supply - LOX supply to the S-IV stage propulsion system involves in-flight pressurization of the stage LOX tanks, equal distribution of LOX to six engines, and engine cutoff operations.

1.2.4.1 LOX Tank Pressurization. The S-IV stage LOX tank is pressurized from two sources. During the S-I stage boost phase of vehicle flight, the tank is pressurized with helium stored in high-pressure spheres. The LOX tank pressurization subsystem meters the helium into the tank to maintain the structural integrity of the tank and to provide the proper LOX input pressure to the engines. After S-IV stage ignition, the tank is pressurized with warm helium from a helium heater assembly.

1.2.4.2 LOX Distribution. The six S-IV stage engines receive equal quantities of LOX from the stage LOX tank through individual suction lines.

1.2.4.3 Engine Cutoff. At S-IV stage engine cutoff, which is initiated by LOX or fuel depletion, shutoff valves in the LOX suction lines terminate LOX flow to the engines.

1.3 SYSTEM DESCRIPTION

1.3.1 LOX Storage Subsystem - The LOX storage subsystem equipment consists of a 125,000-gallon main storage tank, a 28,000-gallon replenish storage tank, LOX vaporizers, and a network of lines and valves necessary for filling, draining, and pressurizing the two storage tanks. The main storage tank stores, under pressure, the major portion of the LOX used for filling the S-I and S-IV stage LOX tanks. The replenish tank stores LOX under pressure and supplies it to the S-I and S-IV stage for topping the LOX tanks and for replenishing LOX boiloff losses.

The LOX vaporizers convert LOX to GOX for pressurizing the main and replenish storage tanks during LOX transfer operations. Each vaporizer has a 42-inch diameter fan powered by a 15-hp electric motor. The fan blows ambient air across the vaporizer coils to effect the LOX-to-GOX conversion.

1.3.2 LOX Transfer Subsystem (Figure 1-1) - The LOX transfer subsystem consists of the equipment required for transfer of LOX in both the main fill and replenish operations to the S-I and S-IV stages. S-I stage main fill and replenish controls are located on the launcher. S-IV stage main fill and replenish controls are located on the umbilical tower. The S-I and S-IV stages transfer pumps and drain valves are located within the LOX storage facility.

1.3.2.1 S-I Stage LOX Transfer Equipment. LOX transfer to the S-I stage LOX tank is accomplished through two transfer lines: a main fill line, and a replenish fill line. Major components within these two lines are described as follows:

a. LOX Transfer Pump A105 (figure 3-1) supplies the line pressure and flow rate necessary for transferring LOX through the S-I stage main fill line. The pump is driven by a 350-hp motor and provides a 2500-gpm discharge into the transfer line. Operation of the pump is initiated and controlled from the LCC.

b. The S-I stage main transfer control equipment (figure 3-2) controls the transfer of LOX to and from the S-I stage through the main LOX transfer line. This portion of the transfer line consists of Pneumatic Valve A31 and Solenoid Valves A2764 and A2765. The pneumatic valve is opened to allow LOX flow to the S-I stage during the transfer line precool and main fill operations, and is opened during the drain operation to allow LOX to flow into the main transfer line from the S-I stage LOX tanks.

c. The fast replenish control (figure 3-2) admits LOX to the S-I stage LOX tanks during fast replenish operations. Fast replenish components include Pneumatic Valve A52 and Solenoid Valves A2760 and A2761. The solenoid valves control Pneumatic Valve A52 and are individually controlled from control panels in the LCC.

d. The slow replenish control (figure 3-2) regulates the admission of LOX to the S-I stage LOX tanks to compensate for LOX boiloff losses. Components that make up this portion of the replenish line are throttle control Pneumatic Valve A55 and Pneumatic Converter A58. The pneumatically operated throttle control valve is a multiposition regulator valve that allows different rates of LOX flow when positioned to each of several positions. Throttle valve position is determined by the differential pressure applied to the dome of the valve. This differential pressure is, in turn, regulated by the LOX tanking computer through Pneumatic Converter A58. During the slow replenish operation, the LOX tanking computer determines the amount of LOX to be added and transmits signals to the pneumatic relay to position the throttle valve accordingly.

1.3.2.2 S-IV Stage LOX Transfer Equipment. LOX from the main storage tank and the replenish storage tank is routed to the S-IV stage by way of a common transfer line that interconnects with the S-IV stage at umbilical swing arm No. 2. Major components within this line are described as follows:

a. LOX Transfer Pump A106 (figure 3-1) supplies the line pressure and flow rate necessary for transferring LOX through the S-IV stage LOX transfer line. The pump is driven by a 200-hp electric motor and is capable of discharging LOX at 1000 gpm. Operation of the pump is remotely controlled from the LCC.

b. The S-IV main transfer control equipment (figure 3-2) is located in the umbilical tower adjacent to swing arm No. 1 and contains pneumatic and electropneumatic valves that control and regulate LOX flow into the S-IV stage. The main transfer control consists of main fill Pneumatic Valve A4005, replenish Pneumatic Valve A4021, and umbilical line vent Pneumatic Valve A4023. The main fill valve is opened during the main fill operation to allow LOX discharge from Transfer Pump A106 to flow into the S-IV stage fill, replenish, and drain line. The replenish valve is opened during the replenish operation to allow LOX to flow from the replenish storage tank into the S-IV LOX container.

1.3.3 LOX Control Subsystem - As shown in figure 1-1, LOX control equipment is located in three areas on launch complex 37. The LOX control panel, LOX components panel, and LOX tanking computer panel are located in propellant loading racks No. 4 and No. 5 of the LCC; the LOX pneumatic console is located in the LOX storage facility, and the LOX tanking computer is located in the AGCS.

1.3.3.1 LOX Control Panel. The LOX control panel originates command for LOX system operations and provides indicators for monitoring these operations.

1.3.3.2 LOX Components Panel. The LOX components panel provides switches for manual operation of LOX transfer components when the manual mode of operation is selected. This mode selection is made when the FUNCTION SELECTOR switch on the LOX control panel is turned to the MANUAL position. The components panel also provides indicators for monitoring system component operations.

1.3.3.3 LOX Pneumatic Console. The LOX pneumatic console provides pneumatic control pressure for the operation of S-I stage LOX transfer line components. The console receives a 3000-psig GN_2 supply from the nitrogen and helium storage battery. (volume IV) and reduces this supply to 750-psig, 120-psig, 50-psig, and 25-psig outputs.

The 750-psig and 25-psig outputs are used to operate pneumatic devices in the LOX transfer subsystem. The 50-psig output is used for purging the LOX transfer lines, and the 120-psig output is used only as an intermediate stage in developing the 25-psig output. Distribution of GN_2 to S-I stage LOX transfer components is effected through solenoid valves which are electrically interlocked with the LOX control panel and the LOX components panel through relay logic networks.

1.3.3.4 LOX Tanking Computer Subsystem. The LOX tanking computer subsystem regulates the level of LOX loaded into the S-I stage LOX tanks with respect to the LOX mass requirements of a given mission. The system consists of LOX Tanking Computer A83, a LOX tanking computer panel, and a digital indicator panel. The computer is located on the second floor of the AGCS building; the tanking computer panel and the digital indicator panel are located in the LCC.

During S-I LOX loading operations, the LOX tanking computer monitors the pressure head in LOX tank O-C and interprets the pressure in terms of LOX mass. The computer is programmed to halt the loading operation when the pressure head reaches a predetermined value. This predetermined pressure head corresponds to the LOX mass requirements for a given vehicle mission and is displayed at the LOX differential pressure digital indicator panel. Should LOX mass requirements change, the predetermined pressure head can be corrected plus or minus 0.460 psi by means of a telephone-type dial and a toggle switch on the LOX computer panel. The correction factor is dialed in with the telephone-type dial and the polarity of the correction factor is entered by positioning the toggle switch to either the positive or the negative position.

The pressure correction factor is also displayed in the pressure correction digital indicator.

The LOX tanking computer also controls the replenishment of LOX lost in boiloff. During the replenish operation the computer monitors LOX depletion and controls a throttle valve that admits small quantities of LOX to the S-I stage LOX tanks to compensate for the depletion.

1.3.3.5 S-IV Stage Propellant Loading Control System. The S-IV stage propellant loading control system consists of the S-IV stage propellant utilization (PU) system and control equipment in the ground complex. The PU system consists of a capacitance-type level probe, liquid level sensors, pressure transducers, pressure switches and associated plumbing and wiring. The ground complex control equipment consists of equipment for determining propellant levels and control panels for monitoring and controlling propellant loading. During S-IV stage LOX loading operations, the system monitors LOX tank levels and terminates the operations when LOX reaches a predetermined level. The system also monitors LOX depletion due to boiloff and controls the replenishment of LOX through a modulating replenish valve.

1.3.4 S-I Stage LOX Subsystems (Figure 3-3) - Major components and subsystems in the S-I stage portion of the LOX system are identified in figure 1-1 and described in the following paragraphs.

1.3.4.1 S-I Stage LOX Tanks. The S-I stage contains one center LOX tank O-C surrounded by four outer LOX tanks O-1, O-2, O-3, and O-4. The four outer tanks are mounted alternately between four fuel tanks. Suction lines from each outer tank supply LOX to one inboard and one outboard engine. Each outer LOX tank measures 70 inches in diameter and 677 inches in length and has a maximum capacity of 10,912 gallons. Ullage, provided for expansion and pressurization of the LOX, reduces the

liquid capacity of the tanks to 10,425 gallons. The center tank measures 105 inches in diameter and 677 inches in length. The central tank liquid capacity is 24,271 gallons, with ullage reducing the usable capacity to 22,980 gallons. Interconnect lines that join the four outer tank sumps to the center tank sump maintain an equal LOX level in all tanks. This arrangement allows the tanks to be filled through a common fill connector and replenished through a common replenish connector.

1.3.4.2 S-I Stage LOX Tank Pressurization Subsystem. The S-I stage LOX tank pressurization subsystem regulates LOX tank pressure to maintain an approximately equal LOX pressure head in the suction lines during engine operation. The subsystem is comprised of pressure switches that monitor tank pressure and a network of pressurization lines that carry the pressurization medium to the tanks.

Interconnect lines join the ullage areas of the tanks to maintain equal pressure distribution to all five tanks. During the final 100 seconds of a prelaunch countdown, the subsystem pressurizes the tanks with helium supplied from a ground source. After vehicle liftoff, however, the tanks are pressurized with GOX generated from LOX passed through engine heat exchangers. Vent and pressure relief valves are also included in the subsystem to prevent overpressurization of the tanks.

1.3.5 S-IB Stage LOX Subsystems (Figure 3-4) - Major components and subsystems that comprise the S-IV stage portion of the LOX system are identified in figure 1-1 and described in the following paragraphs.

1.3.5.1 S-IV Stage LOX Tank. S-IV stage LOX tank E152 has a volume of 1262 cu ft, including 4-percent ullage. This gives a capacity 9063 gallons. The LOX tank is mounted below and is physically separated from the LH_2 tank by a honeycomb fiberglass bulkhead faced with aluminum.

A thermally insulated LOX line, including a flexible bellows section, extends from the bottom of the tank to the RL10A-3 engines.

1.3.5.2 S-IV Stage LOX Tank Pressurization Subsystem. The S-IV stage LOX tank pressurization subsystem regulates LOX tank pressure to maintain a constant LOX pressure head into the RL10A-3 engines during vehicle flight.

1.4 STORAGE OPERATIONS

LOX for filling main LOX Storage Tank A300 and replenish LOX Storage Tank A200 is transported to the launch complex in mobile service trailers. Approximately 125,000 gallons of LOX are pumped into the main LOX storage tank, and approximately 28,000 gallons are pumped into the replenish storage tank.

Before the main LOX storage tank is filled, the annular space between the tank walls is pressurized to 0.1 psig with dry GN_2. This is done to prevent the accumulation of moisture in tne Pearlite insulation between the walls. Two storage cylinders supply the GN_2.

A vacuum is maintained in the space between the walls of the replenish LOX storage tank to prevent moisture accumulation. Connections are provided to allow re-evacuation of the space as necessary.

1.5 TRANSFER OPERATIONS

1.5.1 Modes of Operation - LOX transfer operations may be performed in any one of three modes; operate, simulate, and manual. These mode selections are made by positioning the FUNCTION SELECTOR switch on the LOX control panel to the OPERATE, SIMULATE, or MANUAL position. The panel also provides a two- position sequence selector switch that permits selection of automatic or semiautomatic sequencing of operations in the operate mode.

1.5.1.1 Operate Mode. In the operate mode, system operations are controlled by command signals from automatic circuitry in the LCC, and depending on the position of the sequence selector switch on the LOX control panel, may be sequenced automatically or semiautomatically. When automatic sequencing is selected, system operations proceed , without interruption, from storage tank pressurization to completion of the S-I stage and S-IV stage LOX tank pressurization operations. When semiautomatic sequencing is selected, control of LOX transfer operations is transferred to five pushbutton switches. The switches permit semiautomatic sequencing of the operations through the S-I stage main fill operation. Upon completion of this operation, the remaining operations are sequenced automatically.

Automatic sequencing of the operate mode is initiated by positioning LOX control panel switches as follows:

a. The POWER switch is placed in the ON position. This switch controls electrical power to the LOX control panel components.

b. The four-position FUNCTION SELECTOR switch is placed in the OPERATE position.

c. The SEQUENCE switch is placed in the AUTO position. This initiates and automatically sequences the following operations.

   1. Main and replenish LOX storage tanks pressurization.

   2. S-IV stage LOX fill and drain line precool.

   3. S-IV stage LOX container fast fill.

   4. S-I stage fill and drain line precool.

   5. S-I stage LOX tanks fast fill.

   6. LOX replenish lines precool.

   7. S-I stage LOX replenish.

   8. S-IV stage LOX replenish.

Semiautomatic sequencing in the operate mode is used primarily for prelaunch system operational checkout and is performed by operating LOX control panel switches as follows:

a. The POWER switch is positioned to the ON position.

b. The four-position FUNCTION SELECTOR switch is turned to the OPERATE position.

c. The SEQUENCE switch is turned to the SEMI-AUTO position. At this position the sequence switch transfers semi-automatic control of the LOX system operations to the following switches.

1. The PRESSURIZE STOR TANKS switch, which initiates pressurization of the main and replenish LOX storage tanks.

2. The PRECOOL S-IV FILL LINE switch, which initiates the S-IV fill and drain line precool operation.

3. The MAIN FILL S-IV switch, which initiates the S-IV fast fill operation.

4. The PRECOOL S-I FILL LINE switch, which initiates the S-I fill and drain line precool operation.

5. The MAIN FILL S-I fill switch, which initiates the S-I main fill operation and transfers remaining operations to the automatic mode of operation.

1.5.1.2 Simulate Mode. The simulate mode of operation is selected by positioning the FUNCTION SELECTOR switch on the LOX control panel to the SIMULATE position. Operations performed in this mode of operation are identical to those performed in the automatic sequence of the operate mode with one exception; no LOX flow occurs. Manual valves in the transfer line remain closed and the LOX transfer pumps are not operated.

1.5.1.3 Manual Mode. In the manual mode of operation, system components can be individually operated from the LOX components panel to verify component operation. This mode of operation is selected by positioning the FUNCTION SELECTOR switch on the LOX control panel to the MANUAL position. At the MANUAL position, the switch transfers control power to individual component switches on the LOX components panel.

1.5.2 Preparation for Vehicle LOX Loading - A manual check of all LOX system components must be conducted and their proper operation verified before either an actual or a simulated loading operation is attempted. Prior to the LOX loading operation the system must be placed in a state of readiness as indicated below.

a. The following valves must be opened:

1. S-IV stage fill line Manual Valve A73.

2. Suction line Manual Valve A307.

3. Suction line Manual Valve A309

4. Return line Manual Valve A310.

5. Vaporizer supply line Manual Valve A323.

6. Main tank vent line shutoff Manual Valve A327.

7. S-I stage fill line Manual Valve A26

8. S-I stage replenish line Manual Valve A75.

9. Replenish tank LOX withdrawal Manual Valve A210.

10. Replenish tank vent line shutoff Manual Valve A220.

11. Replenish LOX tank vaporizer LOX supply line Manual Valve A227.

b. The following valves must be closed:

1. Drain line Manual Valve A68.

2. S-IV stage fill line drain Manual Valve A70.

3. S-I stage fill line drain Manual Valve A71.

4. S-I stage transfer pump suction line drain Manual Valve A112.

5. S-IV stage transfer pump suction line drain Manual Valve A113.

6. Main tank vent line drain Manual Valve A133.

7. Main tank trycock Manual Valve A311.

8. Vaporizer bypass Manual Valves A319 and A320.

9. Replenish tank vent line drain Manual Valve A81.

10. Replenish tank vaporizer bypass Manual Valves A223 and A224.

11. Replenish tank trycock Manual Valve A230.

c. The following conditions must be fulfilled prior to starting the LOX loading operation:

1. S-I stage LOX tank vents open.

2. S-I stage LOX prevalves open.

3. S-I stage 750-psig pneumatic pressure available.

4. S-I stage LOX tanking computer ready.

5. Launcher 750- and 25-psig pneumatic pressure available.

6. S-IV stage pneumatic pressure available.

7. S-IV stage tower complex pneumatic pressure available.

8. S-IV stage ready for LOX loading.

9. Storage facility 750-psig pneumatic pressure available.

1.5.3 Storage Tank Pressurization

1.5.3.1 Setup. Storage tank pressurization is initiated at the LOX control panel as follows:

a. The POWER switch is turned to the ON position.

b. The FUNCTION SELECTOR switch is turned to OPERATE.

c. The FILL SEQUENCE switch is positioned to AUTO.

1.5.3.2 Main Tank Pressurization (figure 3-1). Main LOX Storage Tank A300 is pressurized with 30-psig GOX from LOX Vaporizer A305. The pressurization sequence occurs as follows:

a. The main LOX tank pressurization Pneumatic Valve A301 is opened by 750-psig GN_2 from Solenoid Valve A2739.

b. Storage tank vent Pneumatic Valve A1 is closed by 750-psig GN_2 from Solenoid Valve A2736.

c. Main LOX tank vaporizer blower Motor A304 is started.

d. LOX flows from Storage Tank A300 through vaporizer supply Manual Valve A323. main LOX tank pressurization Pneumatic Valve A301. past Relief Valve A321. to Flow Regulator A306.

e. LOX flows through Flow Regulator A306 and into Vaporizer A305. The vaporizer fan blows air across the vaporizer coils to effect the LOX to GOX conversion.

f. Pressurized GOX flows from the vaporizer through vent line shutoff Manual Valve A327 and into the storage tank ullage.

g. As ullage pressure varies from 30 psig. proportional Pneumatic Controller A328 supplies GN_2 control pressure (between 3 and 15 psig) to the flow regulator valve to restore proper ullage pressure.

1.5.3.3 Replenish Tank Pressurization (figure 3-2). Replenish LOX Storage Tank A200 is pressurized with 190-psig GOX from LOX Vaporizer A205. The pressurization sequence occurs as follows:

a. Replenish tank vent Pneumatic Valve A4 is closed by 750-psig GN_2 supplied from Solenoid Valve A2752.

b. Replenish tank pressurization Pneumatic Valve A201 is opened by 750-psig GN_2 supplied from Solenoid Valve A2755.

c. Replenish tank vaporizer blower Motor A204 is started.

d. LOX flows from the replenish tank through vaporizer supply Manual Valve A227 and replenish tank pressurization Pneumatic Valve A201 to Flow Regulator A206.

e. LOX flows through Flow Regulator A206 into Vaporizer A205. The vaporizer fan blows air across the coils of the vaporizer to effect the LOX to GOX conversion.

f. Pressurized GOX flows from the vaporizer through vent line shutoff Manual Valve A220 into the replenish tank ullage.

g. As the pressure in the ullage varies from 190 psig, proportional Pneumatic Controller A235 supplies GN_2 control pressure (between 3 and 15 psig) to Flow Regulator A206 to restore the proper ullage pressure.

1.5.4 S-IV Stage LOX Transfer

1.5.4.1 Fill and Drain Line Precool. The S-IV stage LOX fill and drain line precool operation is automatically initiated after the main and replenish storage tanks are pressurized. Immediately preceeding LOX flow in the line, 50-psig GN_2 from valve panel B (volume V) is used to purge Pneumatic Valve A3151 through Orifice A3171 and Quick-Disconnect Coupling A3160 through Orifice A3170. As LOX flows through the line, this purge minimizes fire hazard should there be a LOX leak during the precool operation. After the purge is initiated, the following operations are performed to start LOX flow through the fill and drain line.

a. S-IV stage tank vent and relief Pneumatic Valves E153 and E154 are opened.

b. S-IV stage LOX tank fill and drain Pneumatic Valve E151 is opened.

c. Umbilical line LOX Pneumatic Valve A3151 is opened.

d. Main fill Pneumatic Valve A4005 is opened.

e. Pump discharge Pneumatic Valve A10 is opened.

f. Precool drain and vent Pneumatic Valve A148 is opened (timed to close after 5 minutes).

g. Line vent Pneumatic Valve A13 is closed.

h. Precool drain and vent Pneumatic Valve A149 is closed.

i. Umbilical line vent Pneumatic Valve A4023 is closed.

j. Replenish Pneumatic Valve A4021 is closed.

Pressurized LOX flows from main LOX Storage Tank A300 through Manual Valve A309, past Relief Valve A90, Strainer A100 through Transfer Pump A106. The pump does not operate during the precool operation. From the transfer pump, LOX flows through pump discharge Pneumatic Valve A10, Check Valve A45, Manual Valve A73, and past Relief Valves A43, A47, A44, A98. After Pneumatic Valve A148 closes. flow continues through Pneumatic Valve A4005, Filter A4011, umbilical line LOX Pneumatic Valve A3151, Quick-Disconnect Couplings A3160 and E150, fill and drain Pneumatic Valve E151 and into the S-IV LOX Tank E152. Approximately 4000 pounds of LOX are transferred to the S-IV stage during the precool operation. The tank is vented through Pneumatic Valves E153 and E154.

Immediately after main fill and drain Pneumatic Valve E151 closes, the LOX fill and drain line is purged with 50-psig GN_2 from valve panel B. From the valve panel, the purge enters the line through Check Valve A3165. This purge inerts the atmosphere within the line to minimize fire hazard in the area of the umbilical housing after Pneumatic Valve A3151 closes at vehicle liftoff.

1.5.4.2 Main Fill. The S-IV stage LOX tank fill operation is initiated immediately after completion of the fill line precool operation. The S-IV LOX Transfer Pump A106 is started and Pressure Switch A436 activates at 150 psi. LOX flows, at 1000 gpm to the LOX tank through the same path as that followed during the precool operation. Precool drain and vent Pneumatic Valve A148 is opened when the transfer pump starts, is held open for 40 seconds, and is then closed.

A command signal stops LOX Transfer Pump A106 when the S-IV stage LOX tank has been filled to the 98-percent-full level as determined by the S-IV propellant utilization system and Douglas Aircraft Company (DAC) propellant loading equipment. The command signal also opens line vent Pneumatic Valve A13, precool drain and vent Pneumatic Valve A148, and starts a 15-second timer. Approximately 15-seconds after the LOX level reaches the 98-percent-full level, the S-IV fill and drain Pneumatic Valve E151 is closed, main LOX fill Pneumatic Valve A4005 is closed, and umbilical line vent Pneumatic Valve A4023 is opened. S-IV fill and drain Pneumatic Valve E151 and pump discharge Pneumatic Valve A10 are closed. Precool drain and vent Pneumatic Valve A148 is closed and line vent Pneumatic Valve A13 is opened. LOX is drained from the fill line and vented overboard through Check Valve A4027.

S-IV stage replenish line precooling is initiated upon completion of the S-I stage main LOX fill operation. This action occurs as follows: replenish line vent Pneumatic Valve A136 is closed, umbilical line vent Pneumatic Valve A4023 is closed, replenish Pneumatic Valve A4021 is opened, and replenish precool drain and vent Pneumatic Valve A149 is opened for a period of 30 seconds. LOX flows, under pressure, from replenish Storage Tank A200, through replenish line control Pneumatic Valve A61, past Relief Valves A84, A146, and A147, through Manual Valve A75, and through Pneumatic Valve A149 and Check Valve A150. LOX also flows through Pneumatic Valve A4021, Strainer A4011, Pneumatic Valve A3151, and Quick-Disconnect Couplings A3160 and and E150 to the fill and drain Pneumatic Valve E151 which is closed.

1.5.4.3 LOX Bubbling. The S-IV stage LOX suction lines are bubbled with a cold helium supply from valve panel B (volume V). The purpose of this bubbling operation is to prevent temperature stratification in the LOX tank. Bubbling is initiated at approximately T -450 seconds in the countdown and is continued until T -150 seconds. The operation is initiated by a command signal that opens Electropneumatic Valves E166 and E167. Cold He is routed to each suction line through Check Valve E171 and Orifice E172. Helium also flows through Electropneumatic Valve E166, past Thermal Switch E162, through Orifice E163 and is vented overboard. After approximately 5 minutes, bubbling is terminated by deenergizing Electropneumatic Valves E166 and E167.

1.5.4.4 Replenish. The S-IV stage LOX replenish operation is initiated by the same timer that closes Pneumatic Valve A149 after 30 seconds of replenish line precooling. When Pneumatic Valve A149 is closed, fill and drain Pneumatic Valve E151 is opened.

Pressurized LOX flows from a tee connection in the LOX replenish line (downstream from replenish line control Pneumatic Valve A61) through Manual Valve A75, replenish Pneumatic Valve A4021, Strainer A4011, umbilical line Pneumatic Valve A3151, Quick-Disconnect Couplings A3160 and E150, fill and drain Pneumatic Valve E151 and into the S-IV stage LOX tank. GOX is vented from the tank through the S-IV vent Pneumatic Valves E153 and E154.

During the replenish operation, the amount of LOX allowed to flow through Valve A4021 is regulated to maintain the S-IV LOX tank level between 99.25 and 99.75 percent of a predetermined full level. The position of Pneumatic Valve A4021 is controlled by Solenoid Valve A4022 which in turn, is controlled by an analog signal from DAC propellant loading control equipment. From T -150 seconds to approximately T -50 seconds in the countdown sequence, throttle Pneumatic Valve A4021 is fully opened. This allows rapid filling of the LOX tank to the 100-percent-full level. When the LOX tank level probe signals the DAC propellant loading equipment that the LOX container is 100 percent full, the propellant loading equipment generates an analog signal that causes Pneumatic Valve A4021 to close. Coincident with closure of A4021, fill and drain Pneumatic Valve E151 is closed and umbilical line drain Pneumatic Valve A4023 is opened. Residual LOX in the upstream portion of the replenish line drains through the umbilical line drain pneumatic valve and is vented to the ground through Check Valve A4027.

At vehicle lift off, umbilical line Pneumatic Valve A3151 is closed to prevent the release of GOX from Quick-Disconnect Coupling A3160 and thereby prevent a fire hazard in the area of the swing arm No. 2 umbilical housing.

1.5.4.5 S-IV LOX Tank Pressurization. LOX tank E152 is pressurized to approximately 47.0 psia with cold He from valve panel B. Pressurization is initiated at T -150 seconds in the countdown sequence. The S-IV LOX tank vent Pneumatic Valves E153 and E154 are closed by deenergizing Solenoid Valve E214 and E212. Approximately 5 seconds later, Solenoid Valve E213 is energized to boost close the LOX tank vent valves. When the vent valves close there is less than 4.5 psia in the LOX tank and Pressure Switch E283 is deactuated, keeping Electropneumatic Valve E236 open. Cold He flows from valve panel B and into the vehicle through Coupling Halves A3157 and E225, Check Valve E226, Filter E228, Electropneumatic Valve E236, helium Heater Assembly E241 (not in operation), Orifice E240 and into the LOX tank. When the pressure in the LOX tank reaches 47.0 psia, Pressure Switch E283 actuates and closes Electropneumatic Valve E236. Pressure Switch E281 actuates at 44 psia and provides a monitor for minimum liftoff pressure. Pressure Switch E280 actuates at 52 psia to provide overpressure protection.

1.5.4.6 LOX Tank Drain. The S-IV Stage LOX tank can be drained at any time in relation to draining the S-I stage tanks. Before the S-IV Stage LOX tank can be drained, it must be pressurized and Storage Tanks A300 and A200 must be depressurized. Vent and relief Pneumatic Valves E153 and E154 are closed and the S-IV stage LOX tank is pressurized with 3000-psig He from the vehicle control pressure system to start the LOX container drain sequence. After the S-IV stage LOX tank is pressurized main fill Pneumatic Valves A4005 and fill and drain Pneumatic Valve E151 are opened, and a 5-minute timer is started. The timer provides 5 minutes for main LOX storage tank depressurization before drain operation initiation. The main LOX storage tank is depressurized as follows: vent Pneumatic Valve A1 is opened, main LOX tank pressurization Pneumatic Valve A301 is closed, and vaporizer blower Motor A304 is stopped.

Five minutes after pressurization of the S-IV stage LOX tank, upper stage line drain Pneumatic Valve A22 is opened by a signal from the timer. Pressurized LOX flows from the S-IV stage LOX tank through fill and drain Pneumatic Valve E151, Quick-Disconnect Coupling E150, Quick-Disconnect Coupling A3160, umbilical line Pneumatic Valve A3151, Strainer A4011, main fill Pneumatic Valve A4005, Manual Valve A73, drain Pneumatic Valve A22, Check Valve A30, Strainer A104, Manual Valve A310 and into the main LOX storage tank. S-IV stage LOX drain terminates when fill and drain Pneumatic Valve E151, Pneumatic Valve A4005, and Pneumatic Valve A22 close. Drain and vent Pneumatic Valve A148 and upper stage line vent Pneumatic Valve A13 are opened to vent the main fill and replenish lines and are later closed.

1.5.5 S-I Stage LOX Transfer

1.5.5.1 Fill and Drain Line Precool. The fill and drain line precool operation requires approximately 6.5 minutes and occurs as follows: pump discharge Pneumatic Valve A7 is opened, main fill and drain Pneumatic Valve A31 is opened, main fill and

drain Pneumatic Valve B152 is opened. Line drain Pneumatic Valve A16 is closed, and mast drain Pneumatic Valve A34 is closed. Pressure in the main LOX storage tank causes LOX flow from the storage tank through Manual Valve A307, Strainer A99, Transfer Pump A105 (pump does not operate during precool), pump discharge Pneumatic Valve A7, Check Valve A115, Manual Valve A26, main fill Pneumatic Valve A31, Retractable Coupling A4600, Nozzle B153, main fill and drain Pneumatic Valve B152 and into LOX tank O-3. LOX flows to the other S-I LOX tanks through the lower LOX tank interconnecting manifold.

1.5.5.2 Main Fill. Upon completion of the fill and drain line precool operation, the main fill operation is initiated by starting Transfer Pump A105. The transfer pump provides a 2500 gpm LOX flow to the S-I stage LOX tanks through the same lines used in the fill and drain precool operation. Transfer pump operation is verified throughout the operation by Pressure Switch A435. When the transfer pump discharge pressure reaches 160 psig, the switch actuates and transmits a signal to LOX control equipment in the LCC.

The main fill operation continues until the LOX tanking computer senses that the S-I stage LOX tanks are 95-percent filled. At this point in the operation, the tanking computer generates a command signal that starts a 15-second timer and initiates the following: Transfer Pump A105 is stopped; main fill and drain Pneumatic Valve B152 is closed; throttle bypass Pneumatic Valve A52 is closed; line drain Pneumatic Valve A19 is opened, and line vent Pneumatic Valve A16 is opened. When the 15-second timer expires, mast drain Pneumatic Valve A34 is opened; main fill and drain Pneumatic Valve A31 is closed, and pump discharge Pneumatic Valve A7 is closed. Residual LOX in the transfer line is vented through Pneumatic Valve A34 and Check Valve A85 as well as through Pneumatic Valve A16 and Check Valve A76.

1.5.5.3 Replenish Line Precool. The replenish line precool operation is performed during the S-I main fill operation in order to permit the immediate initiation of the replenish operation upon termination of the main fill operation. When the S-I stage LOX tanks are 75-percent filled, the LOX tanking computer initiates the replenish line precool operation as follows: S-I replenish Pneumatic Valve B151 is opened; replenish throttle control Pneumatic Valve A55 and replenish throttle bypass Pneumatic Valve A52 are opened; replenish line control Pneumatic Valve A61 is opened; S-I replenish line drain Pneumatic Valve A143 is closed, and replenish line vent Pneumatic Valve A136 is closed. LOX flows from Replenish Storage Tank A200 through Manual Valve A210, replenish control Pneumatic Valve A61, Manual Valve A75, replenish throttle Pneumatic Valve A55 and replenish throttle bypass Pneumatic Valve A52, Coupling A430 and Weldment Coupling B150, replenish Pneumatic Valve B151 and into LOX tank O-4.

1.5.5.4 Replenish. At termination of the main fill operation, the S-I stage LOX tanks are replenished with LOX from replenish Storage Tank A200 and are maintained at the 100-percent-full level by LOX Tanking Computer A83 and replenish throttle Pneumatic Valve A55. LOX flow to the S-I stage LOX tanks follows the flow path used in the S-I replenish line precool operation with one exception; throttle bypass Pneumatic Valve A52 is closed. The replenish operation continues until T -150 seconds in the countdown sequence and is terminated by the following actions:

a. Replenish Pneumatic Valve B151 is closed.

b. Replenish throttle control Pneumatic Valve A55 is closed.

c. Replenish line drain Pneumatic Valve A143 is opened.

d. Residual LOX in the replenish line drains through replenish line drain Pneumatic Valve A143 and Check Valve A96.

1.5.5.5 LOX Bubbling. During S-I stage LOX filling operations, and prior to LOX tank pressurization, the S-I stage LOX tanks and suction lines are bubbled with gaseous helium. This preflight bubbling prevents LOX temperature stratification in the LOX tanks and suction lines and thereby prevents cavitation in engine suction pumps and reduces LOX boiloff.

The He supply is routed from valve panel No. 10 at 315 psig and is coupled into the S-I stage through short cable mast No. 4 and Quick-Disconnect Couplings A6610 and B450. Within the stage, the He supply is distributed to each suction line through individual branch lines that extend from a common ring manifold. Helium flow into each suction line is reduced to 70 scfm by Orifices B451. After the He bubbles through the suction lines and the LOX tanks, it is vented to the atmosphere through vent Pneumatic Valves B171-1, B171-2, and B172.

1.5.5.6 LOX Tank Pressurization. The S-I stage LOX tanks are pressurized to provide the required inlet pressure to the H-1 engine LOX turbopumps. Prelaunch pressurization of the tanks is provided by a He source from valve panel No. 10. Preflight pressurization of the LOX tanks begins at termination of the LOX bubbling operation. Vent and relief Pneumatic Valves B171-1 and B171-2 and LOX vent Pneumatic Valve B172 are closed by deenergizing Solenoid Valves B215 and B222. From valve panel No. 10, a 3000-psig He source is routed through the launcher and is coupled into the stage through short cable mast No. 2 and Quick-Disconnect Couplings A6508 and B385. From Quick-Disconnect Coupling B385, He flows through Check Valve B387 and into LOX tank O-C. The pressurization supply is equally distributed from LOX tank O-C to the outer LOX tanks through lines that interconnect the ullage areas of the tanks. When pressure in the LOX tanks reaches 59.5 psia, Pressure Switch B167 actuates and initiates a signal that terminates the He supply. If Pressure Switch B167 fails, Pressure Switch B169 provides overpressure protection for the tanks. Should the LOX tank pressure reach 68 psia, Pressure Switch B169 actuates and initiates a command signal that opens Solenoid Valve B215. When Solenoid Valve B215 opens, LOX vent Pneumatic Valve B172 and vent and relief Pneumatic Valve B171-1 are opened, and LOX tank pressure is released to the atmosphere. Control of the He pressurization supply by Pressure Switch B167 continues until vehicle liftoff. At liftoff, the He supply is terminated by a signal from the vehicle liftoff switches.

1.5.5.7 LOX Tanks Drain. The S-I stage LOX tanks can be drained before or after the S-IV stage LOX tank is drained. To initiate the S-I LOX tank drain operation, a five minute timer is started, mast drain Pneumatic Value A34 is closed, vent and relief Pneumatic Valves B171-1, B171-2, and Bl72 are opened, fill and drain Pneumatic

Valve B152 is opened, and main LOX fill and drain Pneumatic Valve A31 is opened. Unless previously accomplished, the main LOX storage tank is depressurized while the 5-minute timer is running. When the 5-minute timer expires it initiates a signal that causes the S-I line drain Pneumatic Valve to open. LOX flows from the S-I stage LOX tanks through the lower LOX tank interconnecting manifold to LOX tank O-3, through fill and drain Pneumatic Valve B152, Nozzle B153 and Retractable Coupling Assembly A4600, fill and drain Pneumatic Valve A31, Manual Valve A310 into the LOX storage tank.

S-I stage LOX drain is terminated by the closure of fill and drain Pneumatic Valve B152, fill and drain Pneumatic Valve A31 and line drain Pneumatic Valve A19. Pneumatic Valves A34 and A16 are opened to drain and vent the transfer lines.

1.6 S-I STAGE PROPULSION SYSTEM SUPPLY OPERATIONS

1.6.1 LOX Tanks Pressurization - Two LOX tank pressurization supplies are available during the period between engine ignition and vehicle liftoff: a GOX supply from the H-1 engine heat exchangers and He from valve panel No. 10.

In-flight pressurization is maintained by GOX produced by LOX vaporization in the H-1 engine heat exchangers. GOX from the heat exchanger flows into a common manifold, through flow control regulator Pneumatic Valve B170 and into LOX tank O-C. The outer LOX tanks receive GOX through upper interconnecting lines from tank O-C. The pneumatic flow control valve senses LOX tank O-C ullage pressure and controls the flow of GOX to the tanks to maintain a pressure of approximately 60 psia. Vent and relief valves provide protection against overpressurization.

1.6.2 LOX Distribution and Engine Cutoff - Each outer LOX tank supplies LOX to one inboard engine and one outboard engine. The LOX flows into two suction lines, through Pneumatic Valves B115 (prevalves) and to the inlet side of the H-1 engine turbopumps. Two seconds after the fuel level in either tank F-2 or F-4 falls below Liquid Level Sensors B104 (volume I), or the LOX level in LOX tanks O-2 and O-4 falls below Liquid Level Sensors B161-1 or B161-2, the flight computer initiates a signal that fires the inboard engine Conax valves. The outboard engines are normally shut down by a 6-second timer that is initiated at inboard engine cutoff. However, the engines will be shut down before the timer expires if either of the following actions occurs: the outboard engine thrust OK pressure switches deactuate due to LOX depletion, or the fuel level falls below the fuel depletion liquid level sensors in the sumps of fuel tanks F-2 and F-4.

Pneumatic Valves B155 (prevalves) are normally-closed shutoff valves that control LOX flow to the H-1 engines. One prevalve is provided for each H-1 engine. The prevalves are held open during engine operation and are closed as part of the normal H-1 engine cutoff sequence. A 750-psig GN_2 control pressure supply is routed from distribution Manifold B211 (volume V_i) through Solenoid Valve B217 (one for each prevalve) for prevalve operation. Because each prevalve is individually controlled by a Solenoid Valve B217, the prevalves may be operated singularly or in any combination.

In the event of individual engine failure during flight, the dead-engine Conax valve signals the appropriate Solenoid Valve B217 to close the dead-engine Pneumatic Valve B155, thus shutting off the LOX supply to the dead engine. The LOX tank interconnecting manifold then equally distributes the dead-engine LOX supply to the other engines.

1.7 S-IV STAGE PROPULSION SYSTEM SUPPLY OPERATIONS

1.7.1 LOX Tank Pressurization - During S-I stage flight, cold He is supplied from Storage Spheres E233, E234, and E235 to pressurize the S-IV stage LOX tank. When tank pressure drops below 45.0 psia, Pressure Switch E283 deactuates and allows Electropneumatic Valve E236 to open. Cold He flows from the spheres through Filter E230, Pressure Regulator E229, Electropneumatic Valve E236, helium Heater Assembly E241 (not in operation), Orifice E240 and into the LOX tank. When tank pressure again reaches 47 psig, Pressure Switch E283 actuates and causes Electropneumatic Valve E236 to close.

Pressurization of the LOX tank during S-IV stage operation is obtained from helium Heater Assembly E241. At a predetermined time after S-I/S-IV separation, LOX Electropneumatic Valve E216 is opened, LH_2 Electropneumatic Valve E215 is opened and Igniters E242 and E244 are energized. LOX and LH_2 are burned in the combustion chamber of the heater and the gases are exhausted overboard. Thermal Switch E246 provides a monitor for the heater. If the heater temperature drops to 110 (± 10) F, the thermal switch signals LOX Pneumatic Valve E216 and LH_2 Pneumatic Valve E215 to open.

Cold He is supplied to the heater from Spheres E233, E234, and E235 through the same path followed during S-I stage flight. When the command is given to open LH_2 Electropneumatic Valve E215, the control for Electropneumatic Valve E236 is transferred from Pressure Switch E283 to Pressure Switch E237, and the control of Electropneumatic Valve E238 is transferred to Pressure Switch E237. When pressure in Plenum Chamber E243 is raised to 330 psig, Pressure Switch E237 picks up and causes Electropneumatic Valve E236 to close. If pressure in the LOX tank drops to 45.0 psia, Pressure Switch E283 deactuates and opens Electropneumatic Valve E238. This allows He to flow through the secondary coil of the heater, thereby increasing He flow into the LOX container. When pressure in the LOX tank again reaches 47.0 psig, Pressure Switch E283 actuates and closes Electropneumatic Valve E238.

1.7.2 LOX Distribution and Engine Cutoff - LOX distribution begins during RL10A-3 engine cooldown and terminates at engine cutoff. During engine operation, LOX flows from the LOX tank to the six engines through six suction lines. Shutoff valves in each suction line control LOX flow into engine turbopumps. Engine operation is terminated by either LOX or LH_2 depletion. When LH_2 or LOX depletes to a predetermined level, the LH_2 and LOX shutoff valves are closed and engine cutoff occurs.

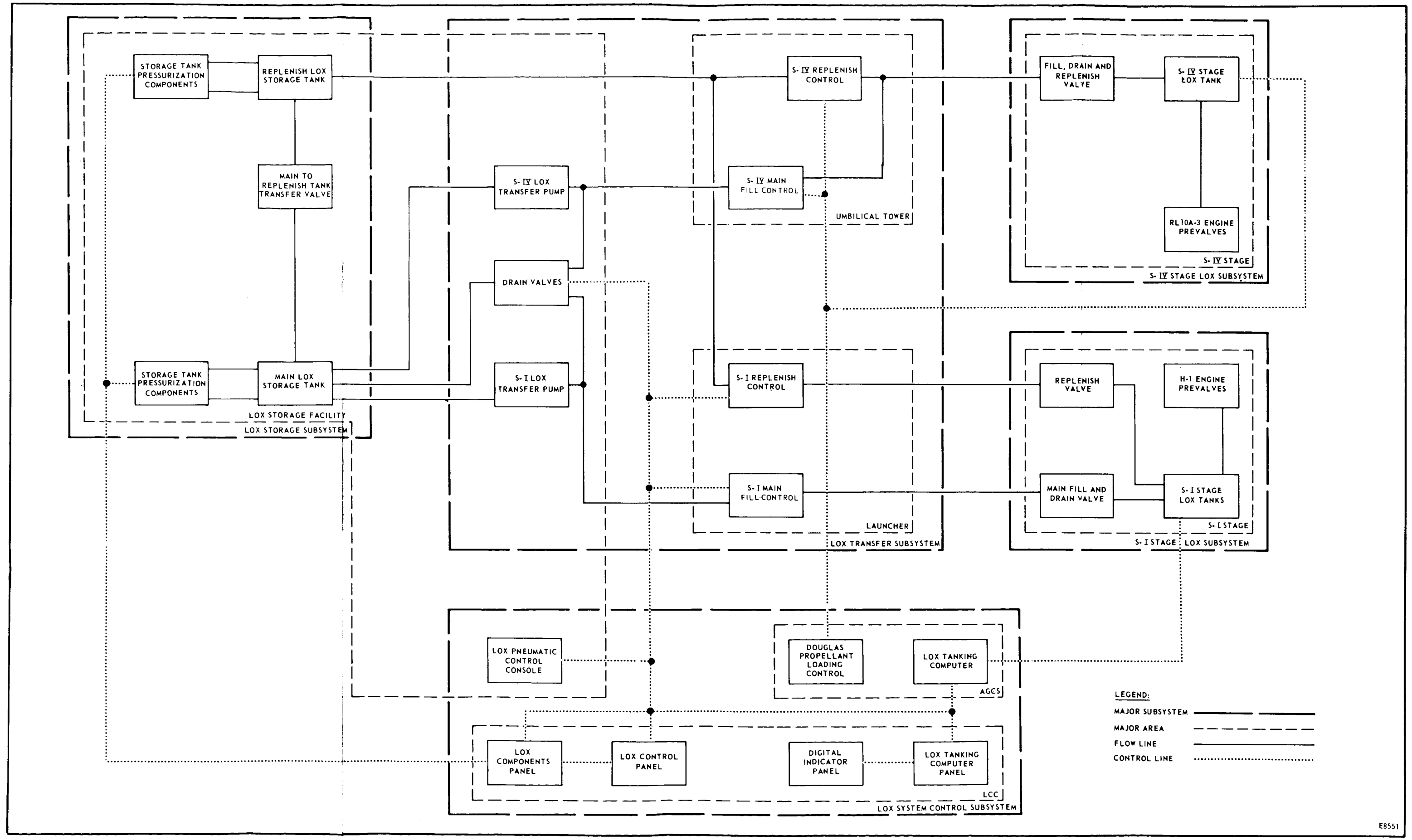

Figure 1-1. Launch Vehicle SA-10 and Launch Complex 37B LOX System - Block Diagram

Section 2

INDEX OF FINDING NUMBERS

This section contains an alpha-numerical list, by finding number, of the LOX system components that function during a prelaunch countdown, during vehicle flight, or in the event of a launch cancellation. The finding numbers listed identify components on system schematic diagrams provided in section 3. Additional columns in the index of finding numbers provide pertinent information such as component description, function, part number, and the supplier's name and part number. A break will occur in the alpha-numeric sequence of finding numbers when a component, or component series is non-functional during the countdown, functional only in the event of a malfunction, functional in terms of a maintenance operation only, or is part of another functional system.

The letter prefix of a finding number identifies the component location with respect to either the launch complex or an area of the launch vehicle. The letter prefixes used in this eleven-volume set are listed below.

FINDING NUMBER PREFIX	DESIGNATED AREA
A	Launch complex
B	S-I stage
E	S-IV stage
G	Instrument unit
H	Payload

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A1	1	Valve, Pneumatic	6 in., main storage tank vent	Hydromatics, Inc. Model A132S6	10427400	
A2 and A3 are not functionally applicable to this system.						
A4	1	Valve, Pneumatic	4 in., replenish storage tank vent	Hydromatics, Inc. Model A132P5	10427321	
A5 and A6 are not functionally applicable to this system.						
A7	1	Valve, Pneumatic	6 in., S-I pump discharge	Hydromatics, Inc. Model A132S5	10427325	
A8 and A9 are not functionally applicable to this system.						
A10	1	Valve, Pneumatic	4 in., S-IV pump discharge	Hydromatics, Inc. Model A132P6	10427324	
A11 and A12 are not functionally applicable to this system.						
A13	1	Valve, Pneumatic	4 in., S-IV fill line vent	Hydromatics, Inc. Model A132P5	10427321	
A14 and A15 are not functionally applicable to this system.						
A16	1	Valve, Pneumatic	4 in., S-I fill line vent	Hydromatics, Inc. Model A132P5	10427321	
A17 and A18 are not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A19	1	Valve, Pneumatic	6 in., S-I fill line drain	Hydromatics, Inc. Model A132S5	10427325	
A20 and A21 are not functionally applicable to this system.						
A22	1	Valve, Pneumatic	6 in., S-IV fill line drain	Hydromatics, Inc. Model A132S5	10427325	
A23 through A25 are not functionally applicable to this system.						
A26	1	Valve, Manual	8 in., S-I main fill line	Wm. Powell Co. P/N 027209	10427454	
A27 through A29 are not functionally applicable to this system.						
A30	1	Valve, Check	6 in., vehicle drain	Wm. Powell Co. P/N 026178	10427332	
A31	1	Valve, Penumatic	6 in., S-I LOX fill and drain	Hydromatics, Inc. Model A132S5	10427325	53A17
A32 and A33 are not functionally applicable to this system.						
A34	1	Valve, Pneumatic	2 in., S-I mast drain	Hydromatics, Inc. Model A132K4	10427346	53A14
A35 through A42 are not functionally applicable to this system.						
A43	1	Valve, Relief	1 1/2 in.; 300 psig; S-IV fill line	Gardner Johnson & Co. P/N 1192	10427327	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A44	1	Valve, Relief	1-1/2 in.; 300 psig; S-IV fill line	Gardner Johnson & Co. P/N 1192	10427327	
A45	1	Valve, Check	4 in., S-IV pump discharge line	Wm. Powell Co. P/N 026178	10427322	
A46 is not functionally applicable to this system.						
A47	1	Valve, Relief	1-1/2 in.; 300 psig; S-IV fill line	Gardner Johnson & Co. P/N 1192	10427327	
A48 through A51 are not functionally applicable to this system.						
A52	1	Valve, Pneumatic	3 in., S-I replenish throttle valve bypass	Hydromatics, Inc. Model A132M7	10427347	
A53 and A54 are not functionally applicable to this system.						
A55	1	Valve, Pneumatic	2 in., replenish throttle control	Annin Co. Model 1560	10427336	
A56 and A57 are not functionally applicable to this system.						
A58	1	Converter, Pneumatic	Component of tanking computer system	Servomechanism, Inc. P/N 812089	10434805	53A35A3
A59 and A60 are not functionally applicable to this system.						
A61	1	Valve, Pneumatic	3 in., replenish line control	Hydromatics, Inc. Model A132M7	10427347	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A62	1	Valve, Pneumatic	1 in., replenish line control bypass			
A63 through A67 are not functionally applicable to this system.						
A68	1	Valve, Manual	1 in., S-I and S-IV fill line drain	Wm. Powell Co. P/N D-49008	10427343	
A69 is not functionally applicable to this system.						
A70	1	Valve, Manual	1 in., S-IV fill line drain	Wm. Powell Co. P/N D-39844	10427342	
A71	1	Valve, Manual	1 in., S-I pump discharge line drain	Wm. Powell Co. P/N D-39844	10427342	
A72 is not functionally applicable to this system.						
A73	1	Valve, Manual	6 in., S-IV fill and drain line shutoff	Wm. Powell Co. P/N 027209	10427453	
A74 is not functionally applicable to this system.						
A75	1	Valve, Manual	3 in., replenish line shutoff	Wm. Powell Co. P/N 027201	10427340	
A76	1	Valve, Check	4 in., S-I fill line drain vent	Wm. Powell Co. P/N 026178	10427322	
A77 is not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A78	1	Valve, Check	4 in., replenish tank vent check	Wm. Powell Co. P/N 026178	10427322	
A79	1	Valve, Check	6 in.; main storage tank vent check	Wm. Powell Co. P/N 026178	1047332	
A80 is not functionally applicable to this system.						
A81	1	Valve, Manual	1 in., replenish storage tank vent line drain	Wm. Powell Co. P/N D-49008	10427343	
A82 is not functionally applicable to this system.						
A83	1	Computer, LOX Tanking	Component of tanking computer system		10434613	54A8A5
A84	1	Valve, Relief	1 in.; 300 psig; S-I replenish line	Aervalco Model 5530 Part of 10427331	part of 10427331	
A85	1	Valve, Check	2 in.; S-I mast drain check	Wm. Powell Co.	10427339	
A86 is not functionally applicable to this system.						
A87	1	Valve, Relief	1 in.; 300 psig; S-I replenish line	Ladewig Valve Co. P/N 1178-C	10427320	
A88	1	Valve, Relief	1 in.; 75 psig; S-I pump suction line	Gardner Johnson & Co. P/N 1191	10427326	
A89	1	Valve, Relief	1 in.; 75 psig; main storage tank liquid return	Gardner Johnson & Co. P/N 1191	10427326	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A90	1	Valve, Relief	1 in.; 75 psig; S-IV pump suction line	Gardner Johnson & Co. P/N 1191	10427326	
A91 and A92 are not functionally applicable to this system.						
A93	1	Valve, Relief	1 in.; 300 psig; S-IV fill line drain	Ladewig Valve Co. P/N 1178-C	10427320	
A94	1	Valve, Relief	1 in.; 300 psig; S-I fill line drain	Ladewig Valve Co. P/N 1178-C	10427320	
A95	1	Valve, Relief	1 in.; 300 psig; replenish line	Ladewig Valve Co. P/N 1178-C	10427320	
A96	1	Valve, Check	2 in., S-I replenish line drain		10427339	
A97 is not functionally applicable to this system.						
A98	1	Valve, Relief	1-1/2 in.; 300 psig; S-IV fill line	Ladewig Valve Co. P/N 11160-C	10427327	
A99	1	Strainer	8 in.; 2500 gpm, 150 micron; S-I pump suction	Leslie Co.	10427337	
A100	1	Strainer	6 in.; 1000 gpm, 150 micron; S-IV pump suction line	Leslie Co.	10427323	
A101 is not functionally applicable to this system.						
A102	1	Strainer	3 in.; 500 gpm, 150 micron; S-I replenish line	Leslie Co.	10427334	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A103 is not functionally applicable to this system.						
A104	1	Strainer	6 in., 150 micron	Leslie Co.	10427323	
A105	1	Pump, Transfer	350 hp; 2500 gpm; S-I LOX transfer	Byron Jackson Pump, Inc.	10427328	51B1
A106	1	Pump, Transfer	200 hp; 1000 gpm; S-IV LOX transfer	Byron Jackson Pump, Inc.	10427329	51B2
A107 through A109 are not functionally applicable to this system.						
A110	1	Valve, Relief	1-1/2 in.; 300 psig; S-I fill line	Gardner Johnson & Co. P/N 1192	10427327	
A111 is not functionally applicable to this system.						
A112	1	Valve, Manual	1 in., S-I pump suction line drain	Wm. Powell Co. P/N D-49008	10427343	
A113	1	Valve, Manual	1 in., S-IV pump suction line drain	Wm. Powell Co. P/N D-49008	10427343	
A114	1	Valve, Check	2 in., S-I/S-IV fill line drain	Wm. Powell Co.	10427339	
A115	1	Valve, Check	6 in., S-I pump discharge line	Wm. Powell Co. P/N 026178	10427332	
A116 through A132 are not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A133	1	Valve, Manual	1 in., main storage tank vent line drain	Wm. Powell Co. P/N D-49008	10427343	
A134 and A135 are not functionally applicable to this system.						
A136	1	Valve, Pneumatic	1 in.; replenish line vent	Hydromatics, Inc. Model A132F1	10427345	
A137 and A138 are not functionally applicable to this system.						
A139	1	Valve, Relief	1-1/2 in.; 300 psig; S-I fill line	Gardner Johnson & Co. P/N 1192	10427327	
A140	1	Valve, Relief	1-1/2 in.; 300 psig; S-I fill line	Gardner Johnson & Co P/N 1192	10427327	
A141	1	Valve, Relief	1-1/2 in.; 300 psig; S-I fill line	Gardner Johnson & Co P/N 1192	10427327	
A142	1	Valve, Relief	1 in.; 300 psig; S-I mast drain line	Ladewig Valve Co. P/N 1178-C	10427320	
A143	1	Valve, Pneumatic	2 in.; S-I replenish line drain	Hydromatics, Inc. Model A132K4	10427346	
A144 and A145 are not functionally applicable to this system.						
A146	1	Valve, Relief	1 in.; 300 psig; replenish line	Aervalco Model 5530 Part of 10427331	Part of 10427331	
A147	1	Valve, Relief	1 in.; 300 psig; replenish line	Aervalco Model 5530 Part of 10427331	Part of 10427331	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A148	1	Valve, Pneumatic	4 in., S-IV precool drain and vent	Hydromatics, Inc.	10427324	
A149	1	Valve, Pneumatic	3 in., S-IV precool drain and vent	Hydromatics, Inc. Model A132M7	10427347	
A150	1	Valve, Check	4 in., S-IV precool drain and vent line	Wm. Powell Co.	10427332	
A151 through A199 are not functionally applicable to this system.						
A200	1	Tank, Storage	28,000 gallons, LOX replenish	Chicago Bridge & Iron Co.	10427472	
A201	1	Valve, Pneumatic	3 in., replenish storage tank pressurization	Hydromatics, Inc. Model A132M7	10427347	
A202 and A203 are not functionally applicable to this system.						
A204	1	Motor	15 hp; 1750 rpm; replenish storage tank vaporizer		10466648	
A205	1	Vaporizer	Replenish storage tank pressurization	Chicago Bridge & Iron Co.	10427318	
A206	1	Regulator, Flow	2 in.	Annin Co. Model 1660	10427335	
A207 through A209 are not functionally applicable to this system.						
A210	1	Valve, Manual	3 in., replenish line shutoff	Wm. Powell Co.	Part of 10427472	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A211 through A219 are not functionally applicable to this system.						
A220	1	Valve, Manual	6 in., replenish storage tank pressurizing shutoff	Wm. Powell Co.	75M05969	
A221	1	Valve, Relief	3 in. by 4 in., cracks at 205 psig	Kunkle Valve Co. Part of 10427472	Part of 10427472	
A222 is not functionally applicable to this system.						
A223	1	Valve, Manual	3 in., vaporizer by-pass	Wm. Powell Co. P/N 027201	10427340	
A224	1	Valve, Manual	3 in., vaporizer by-pass	Wm. Powell Co. P/N 027201	10427340	
A225	1	Valve, Relief	1 in.; 300 psig; replenish tank pressurizing	Ladewig Valve Co. P/N 1178-C	10427320	
A226	1	Valve, Relief	1 in.; 300 psig; replenish tank pressurizing	Ladewig Valve Co. P/N 1178-C	10427320	
A227	1	Valve, Manual	6 in., replenish tank pressurizing shutoff	Wm. Powell Co.	Part of 10427472	
A228 and A229 are not functionally applicable to this system.						
A230	1	Valve, Manual	1 in., replenish tank liquid level trycock	Wm. Powell Co. P/N D-39844	10427342	
A231	1	Valve, Pneumatic	6 in.		75M06583	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A232 through A234 are not functionally applicable to this system.						
A235	1	Controller, Pneumatic	Output press. 3-15 psig, supply press. 25 psig, sensing press. range 0-300 psig	Mason-Neilan Div. Model 2704	10427402	
A236 through A299 are not functionally applicable to this system.						
A300	1	Tank, Storage	125,000 gallon, LOX	Chicago Bridge and Iron Co.	10427471	
A301	1	Valve, Pneumatic	3 in., main storage tank pressurization	Hydromatics Inc. Model A132M7	10427347	
A302 and A303 are not functionally applicable to this system.						
A304	1	Motor	15 hp:, 1750 rpm; main storage tank vaporizer		10466648	
A305	1	Vaporizer	Main storage tank pressurization	Chicago Bridge and Iron Co.	10427318	
A306	1	Regulator, Flow	2 in.	Annin Co. Model 1660 P/N28265	10427335	
A307	1	Valve, Manual	8 in., S-I fill shutoff	Wm. Powell Co. P/N 027088	10427471	
A308 is not functionally applicable to this system.						
A309	1	Valve, Manual	6 in., S-IV fill shutoff	Wm. Powell Co. P/N B-40084	10427453	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A310	1	Valve, Manual	6 in., main storage tank liquid return	Wm. Powell Co. P/N B-40084	10427453	
A311	1	Valve, Manual	1 in., main storage tank liquid level trycock	Wm. Powell Co. P/N D-49008	10427343	
A312 through A316 are not functionally applicable to this system.						
A317	1	Valve, Relief	45 psig, main storage tank pressurization	J. E. Lonegran Co. Model 41W209M	10427471	
A318 is not functionally applicable to this system.						
A319	1	Valve, Manual	3 in., vaporizer by-pass	Wm. Powell Co. P/N B-50700	10427341	
A320	1	Valve, Manual	3 in., vaporizer by-pass	Wm. Powell Co. P/N B-50700	10427341	
A321	1	Valve, Relief	1 in.; 75 psig; main tank pressurizing	Gardner Johnson & Co. P/N 1191	10427326	
A322	1	Valve, Relief	1 in.; 75 psig; main tank pressurizing	Gardner Johnson & Co. P/N 1191	10427326	
A323	1	Valve, Manual	4 in., main storage tank pressurization shutoff	Wm. Powell Co.	10427471	
A324 through A326 are not functionally applicable to this system.						
A327	1	Valve, Manual	6 in., main storage tank pressurization shutoff	Wm. Powell Co.	10427471	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A328	1	Controller, Pneumatic	25 psig supply press., 3-15 psig output press., 0-40 psig sensing press. range	Mason Neilan Div. Model 2707	10427403	
A329 through A341 are not functionally applicable to this system.						
A342	1	Valve, Vacuum Relief	6 in., actuates at 0.030 psig	Oceco Model T Part of 10427471	10427471	
A343 through A429 are not functionally applicable to this system.						
A430	1	Coupling	3 in., S-I replenish line	NASA	75M03191	
A431 through A434 are not functionally applicable to this system.						
A435	1	Switch, Pressure	actuates at 160 psig		10465302	51A1151
A436	1	Switch, Pressure	actuates at 150 psig		10430024	51A1154
A437 through A2699 are not functionally applicable to this system.						
A2700	1	Gage, Pressure	0-10,000 psig range, 3000 psig supply	U. S. Gage Co.	10437648	
A2701	1	Gage, Pressure	0-1500 psig range, 750 psig discharge	U. S. Gage Co.	10437688	
A2702	1	Gage, Pressure	0-300 psig range, 120 psig supply	U. S. Gage Co.	10437687	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2703	1	Gage, Pressure	0-60 psig range, 25 psig discharge	U. S. Gage Co.	10437686	
A2704	1	Regulator, Pressure	3/8 in.; 3000 psig input, 750 psig output	Grove Valve & Reg. Co. Model 94X	10437651	
A2705	1	Regulator, Pressure	3/8 in.; 750 psig input, 120 psig output	Grove Valve & Reg. Co Model 94X	10437651	
A2706	1	Valve, Regulator	120 psig input, 25 psig output	Moore Products Co. Model 42H50	10437679	
A2707	1	Filter	10 micron, 3000 psig supply line	Permanent Filter Co. P/N 10813-10/30	10437650	
A2708	1	Valve, Relief	900 (± 50) psig relief, 750 psig min. reseat	Republic Mfg. Co. P/N 625B-9-6	10437652	
A2709	1	Valve, Relief	120 (± 10) psig relief, 100 psig min. reseat	Republic Mfg. Co. P/N 625B-3-6	10437680	
A2710	1	Valve, Relief	35 (± 5) psig relief, 25 psig min. reseat	Republic Mfg. Co. P/N 625B-2-8	10437681	
A2711	1	Switch, Pressure	Act. 21.5 (± 0.5) psig rising, deact. 1.5 psig diff. pressure	Southwest Industries P/N 3700 A-4	10437682	51A2S3
A2712	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-375A-6T	10437684	
A2713	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-375A-6T	10437684	
A2714	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-375-6T	10437684	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2715	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-375A-6T	10437684	
A2716	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2717	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2718	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2719	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2720	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-375A-6T	10437684	
A2721	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2722	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2723	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2724	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2725	1	Switch, Pressure	Act. 600 (± 20) psig rising, deact. 50 psig diff. press.	Southwestern Industries, Inc. P/N PS-5100A	10437683	51A2S2
A2726	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-250-4T	10437685	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2727	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-250-4T	10437685	
A2728	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-250-4T	10437685	
A2729	1	Valve, Manual	Shutoff	Robbins Aviation P/N SSNA-250-4T	10437685	
A2730	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2731	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2732	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2733	1	Valve, Manual	Vent	Futurecraft Corp. P/N 30205	10437647	
A2734	1	Orifice	0.059 in. dia.	A. U. Stone & Co. Inc.	10430177	
A2735	1	Valve, Relief	55 (± 5) psig relief, 45 psig min. reseat	Republic Mfg. Co. P/N 625B-3-8	10430169	
A2736	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A13
A2737	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A14
A2738	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A17

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2739	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A16
A2740	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A31
A2741	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A32
A2742	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A35
A2743	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A34
A2744	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A29
A2745	1	Valve, Solenoid	3-way, 2-position N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A28
A2746	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A19
A2747	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A20
A2748	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A22
A2749	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A23
A2750	1	Valve, Solenoid	3-way, 2-position N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A26

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2751	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A25
A2752	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A37
A2753	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A38
A2754	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A41
A2755	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A40
A2756	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A47
A2757	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A46
A2758	1	Valve, Solenoid	3-way, 2-position N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A43
A2759	1	Valve, Solenoid	3-way, 2-position N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A44
A2760	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A35A7
A2761	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A35A8
A2762	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A35A9

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2763	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A35A10
A2764	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A35A16
A2765	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A35A15
A2766	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A35A12
A2767	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A35A13
A2768	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	53A35A2
A2769	1	Orifice	10-12 SCFH flowrate at 20.7 psig	A. U. Stone Co. P/N P-881-3	10428514	
A2770	1	Orifice	10-12 SCFH flowrate at 20-7 psig	A. U. Stone Co. P/N P-881-3	10428514	
A2771	1	Valve, Manual	1/2 in.; 3000 psig; shutoff	Vacco P/N MV-6P-463-2G	10428576	
A2772 through A2780 are not functionally applicable to this system.						
A2781	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A49
A2782	1	Valve, Solenoid	3-way, 2-position, N C	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	51A50

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A2783 through A3150 are not functionally applicable to this system.						
A3151	1	Valve, Pneumatic	3 in., actuation 750 (+ 25) psig GN_2	B. H. Hadley Inc. P/N 11409-1	75M05605	57A12A21
A3152 through A3156 are not functionally applicable to this system.						
A3157	1	Coupling, Quick-Disconnect	Cold He bottle fill from swing arm No. 2	On-Mark Couplings Inc. P/N 1-1162-8	75M05194	
A3158 and A3159 are not functionally applicable to this system.						
A3160	1	Coupling, Quick-Disconnect	Main and replenish LOX to S-IV stage		75M04852	
A3161 through A3164 are not functionally applicable to this system.						
A3165	1	Valve, Check	He purge for S-IV fill line		DAC 3871269-501	
A3166 through A3168 are not functionally applicable to this system.						
A3169 is not functionally applicable to this system.						
A3170	1	Orifice	0.040 dia., He purge		75M06686-1	
A3171	1	Orifice	0.020 in. dia.		75M06713-1	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A3172 through A4001 are not functionally applicable to this system.						
A4002	1	Transducer, Pressure		Giannini Controls Corp. P/N 4512715-15		429PT10
A4003	1	Valve, Solenoid	NC, S-IV precool line valve closing control	Marotta Valve Corp. P/N 202873-113 Model MV-174	10437618	3000A1
A4004	1	Valve, Solenoid	N. O. , S-IV precool line valve opening control	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	3000A2
A4005	1	Valve, Pneumatic	4 in.; Y-type; 1000 gpm	Pacific Valves Inc. P/N 13648-EO	7866160-1	
A4006	1	Valve, Solenoid	4-way, 2-position	Marotta Valve Corp. P/N 804934-1-2	3863940-501	429N515
A4007	1	Valve, Solenoid	NC, S-IV precool line Valve closing control	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	3000A5
A4008	1	Valve, Solenoid	N. O., S-IV precool line valve opening control	Marotta Valve Corp. P/N 202873-113 Model MV-74	10437618	3000A4
A4009	1	Transducer, Pressure		Consolidated Vacuum Corp. P/N GTC-004		
A4010 is not functionally applicable to this system.						
A4011	1	Strainer		Westward Engr. & Fab. Co. P/N 25041	7865921-1	
A4012 through A4014 are not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A4015	1	Transducer, Pressure		Consolidated Vacuum Corp. P/N GTC-004		
A4016 through A4018 are not functionally applicable to this system.						
A4019	1	Transducer, Pressure		Consolidated Vacuum Corp. P/N GTC/004		
A4020 is not functionally applicable to this system.						
A4021	1	Valve, Pneumatic	2 in.; Y-type; 100 gpm at 275 psia	Pacific Valves Inc. P/N 13647-F0	7866161-1	
A4022	1	Valve, Solenoid	4-way, 2-position	Marotta Valve Corp. P/N 804934-1-2	3863940-501	429N517
A4023	1	Valve, Pneumatic	2 in.; Y-type; drain	Pacific Valves Inc. P/N 13647-F0	7866161-1	
A4024	1	Valve, Solenoid	4-way, 2-position	Marotta Valve Corp. P/N 804934-1-2	3863940-501	429N516
A4025	1	Valve, Relief		Ladewig L-1180C-299-3	3864299-1	
A4026 is not functionally applicable to this system.						
A4027	1	Valve, Check		Douglas Aircraft Co. Inc. P/N 7721093-1		
A4028 is not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A4029	1	Switch, Pressure		Customer Component Switches Co. P/N 695-E-24		429PJ1
A4030	1	Valve, Relief		James, Pond and Clark P/N D559T-2M-4		
A4031	1	Snubber, Pressure		Douglas Aircraft Co. Inc. P/N DR4-0.5		
A4032 through A4599 are not functionally applicable to this system.						
A4600	1	Coupling, Retractable		Flexonics Inc. P/N 107435	75M00253	
A4601 through A6507 are not functionally applicable to this system.						
A6508	1	Coupling, Quick-Disconnect	3000 psig He, S-I LOX tank pressurization	E. B. Wiggins Co. P/N 6400R 107A16	75M02214	
A6509 through A6600 are not functionally applicable to this system.						
A6601	1	Coupling, Quick-Disconnect	750 psig GN_2, LOX fill and drain valve control	E. B. Wiggins Co. P/N 6300R109A4	75M02210	
A6602	1	Coupling, Quick-Disconnect	LOX sensing, top	E. B. Wiggins Co. P/N 6200R78A4	75M02212	
A6603 is not functionally applicable to this system.						
A6604	1	Coupling, Quick-Disconnect	750 psig GN_2, LOX replenish valve opening control	E. B. Wiggins Co. P/N 6300R109A4	75M02210	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
A6605	1	Coupling, Quick-Disconnect	LOX sensing, bottom	E. B. Wiggins Co. P/N 6200R78A4	75M02212	
A6606 through A6609 are not functionally applicable to this system.						
A6610	1	Coupling, Quick-Disconnect	325 psig, LOX bubbling	E. B. Wiggins Co. P/N 6200R72A8	75M02207	
A6611 through B149 are not functionally applicable to this system.						
B150	1	Coupling Weldment	3 in.	NASA	20M30050	
B151	1	Valve, Pneumatic	2 in.	Hydromatics, Inc. P/N 131K13B	20M30045	9A18
B152	1	Valve, Pneumatic	6 in.; NC, shutoff; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	20M30042	9A20
B153	1	Nozzle Assembly Quick-Disconnect Coupling	8 in., LOX fill and drain	NASA	20M30202	
B154	1	Coupling, Quick-Disconnect	1/4 in.	E. B. Wiggins Co. P/N 6105R109A4	20M30390	
B155-1	1	Valve, Pneumatic	8 in.; NC; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	60C20884-1	9A27
B155-2	1	Valve, Pneumatic	8 in.; NC; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	60C20884-1	9A30
B155-3	1	Valve, Pneumatic	8 in.; NC 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	60C20884-1	9A33

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B155-4	1	Valve, Pneumatic	8 in.; NC; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	60C20884-1	9A36
B155-5	1	Valve, Pneumatic	8 in.; NC; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	60C20884-1	9A39
B155-6	1	Valve, Pneumatic	8 in.; NC; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	60C20884-1	9A42
B155-7	1	Valve, Pneumatic	8 in.; NC; 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	60C20884-1	9A45
B155-8	1	Valve, Pneumatic	8 in.; NC 750 psig normal operating pressure	Parker Aircraft Co. P/N F61C0017	60C20884-1	9A48
B156	1	Coupling, Quick-Disconnect	1/4 in., LOX sensing, bottom	E. B. Wiggins Co. P/N 6005R78A4	20M30138	
B157	1	Coupling, Quick-Disconnect	1/4 in., LOX sensing, top	E. B. Wiggins Co. P/N 6005R78A4	20M30138	
B158	1	Valve, Manual	3-way, needle; calibration	Benton Corp. P/N 15600	10414087	
B159	1	Switch, Differential Pressure	Actuates at 26.02 (± 0.3) psig diff. press.	Servomechanisms, Inc. P/N 816105, Type TR2124	20M30144	9A21
B160	1	Coupling, Quick-Disconnect	1/4 in.	E. B. Wiggins Co. P/N 6105R109A4	20M30390	
B161-1	1	Sensor, Liquid Level		NASA	20M30429	9A68
B161-2	1	Sensor, Liquid Level		NASA	20M30429	9A70

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B162 through B166 are not functionally applicable to this system.						
B167	1	Switch, Pressure	Actuates at 60.0 (± 0.5) psia, deactuates at 56.0 psia min.	Southwestern Industries Inc.	60C20057	11A59
B168	1	Valve, Manual	3-way, needle; calibration	Benton Corp. P/N 17500	10414076	
B169	1	Switch, Pressure	Actuates at 67.5 (± 0.5) psia, deactuates at 64.0 psia min.	Southwestern Industries Inc.	60C20058	11A57
B170	1	Valve, Pneumatic	6 in.; fully open at 57 psia, fully closed at 63 psia	Parker Aircraft Co. P/N 536-00 89	60C20129	9A50
B171-1	1	Valve, Pneumatic	Relieves at 57 to 62 psig, reseats at 51 psig	NASA	20M30460	11A54
B171-2	1	Valve, Pneumatic	Relieves at 57 to 62 psig; reseats at 51 psig	NASA	20M30460	11A58
B172	1	Valve, Pneumatic	8 in.	NASA	20M30122	11A56
B173 through B214 are not functionally applicable to this system.						
B215	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 218263-113	20M30128	11A55
B216	1	Valve, Solenoid	3-way, 2-position, N. O.	Marotta Valve P/N 218263-113	20M30128	9A17
B217-1	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 218263-113	20M30128	9A25

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B217-2	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 218263-113	20M30128	9A28
B217-3	1	Valve, Solenoid	3-way, 2-position NC	Marotta Valve Corp. P/N 218263-113	20M30128	9A31
B217-4	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 218263-113	20M30128	9A34
B217-5	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 218263-113	20M30128	9A37
B217-6	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 218263-113	20M30128	9A40
B217-7	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 218263-113	20M30128	9A43
B217-8	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 218263-113	20M30128	9A46
B218 through B221 are not functionally applicable to this system.						
B222	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 218263-113	20M30128	11A53
B223 through B384 are not functionally applicable to this system.						
B385	1	Coupling, Quick-Disconnect	1 in.	E. B. Wiggins Co. P/N 6005R92A16	20M30165	
B386 is not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
B387	1	Valve, Check	1 in.	Circle Seal Products Co. P/N P220T16BB(L)	20M30379	
B388 through B449 are not functionally applicable to this system.						
B450	1	Coupling, Quick-Disconnect	1/2 in.	E. B. Wiggins Co. P/N 6005R70A8	20M30141	
B451	8	Orifice	0.102 (± 0.002, -0.000) in. dia	NASA	20M30199	
B452 through E149 are not functionally applicable to this system.						
E150	1	Coupling, Quick-Disconnect		Douglas Aircraft Co. Inc. P/N 1A84412-1	75M04579	
E151	1	Valve, Pneumatic	NC, 475 (± 25) psig actuation	B. H. Hadley P/N 11084-11	DAC P/N 7851806-503	
E152	1	Tank, LOX	1263 cu ft, 45-48 psia		DAC P/N 5863804-507	
E153	1	Valve, Pneumatic	Vent and relief; Relieves at 50 psia, reseats at 47 psia	Calmec Mfg. Corp. P/N 230-501	DAC P/N 7851777-501	
E154	1	Valve, Pneumatic	Vent and relief; Relieves at 50 psia, reseats at 47 psia	Calmec Mfg. Corp. P/N 230-501	DAC P/N 7851777-501	
E155	1	Vortex Eliminator			DAC P/N 5851779-1	
E156	1	Sensor, LOX		Minneapolis-Honeywell P/N FG359B-1	DAC P/N 7866356-501	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
E157 through E161 are not functionally applicable to this system.						
E162	1	Switch, Thermal	Actuates below -298 (± 15) F; deactuates above -258 (± 15) F	Giannini Controls Corp.	DAC P/N 1A65853-1	407A23
E163	1	Orifice	0.093 in. dia		DAC P/N S0268-C6-.093	
E164 and E165 are not functionally applicable to this system.						
E166	1	Valve, Electropneumatic		W. O. Leonard Inc. P/N 194100-3A	DAC P/N 7851845-505	
E167	1	Valve, Electropneumatic		W. O. Leonard Inc. P/N 194100-3A	DAC P/N 7851845-505	
E168	1	Filter		Aircraft Porus Media Co. P/N AC H289-61	DAC P/N 7851840-1	
E169	1	Orifice	0.031 in. dia		DAC P/N S0268-C6-.031	
E170	1	Switch, Pressure	Actuates at 320 (± 10) psia, deactuates at 115 (± 15) psia	Frebank Co. P/N 4940-1	DAC P/N 7871397-1	
E171	6	Valve, Check		W. M. Lanagan Co. P/N 90048	DAC P/N 7851843-501	
E172	6	Orifice	0.031. in. dia		DAC P/N S0268-C4-.031	
E173 through E211 are not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
E212	1	Valve, Solenoid	3-way, NC	Marotta Valve Corp. P/N 223544-1	DAC P/N 7851827-501	
E213	1	Valve, Solenoid	3-way, NC	Marotta Valve Corp. P/N 223544-1	DAC P/N 7851827-501	
E214	1	Valve, Solenoid	3-way, NC	Marotta Valve Corp. P/N 223544-1	DAC P/N 7851827-501	
E215	1	Valve, Pneumatic		Clary Dynamics P/N 524122	DAC P/N 7851767-505	
E216	1	Valve, Pneumatic		Clary Dynamics P/N 524122	DAC P/N 7851767-505	
E217 through E224 are not functionally applicable to this system.						
E225	1	Coupling Quick-Disconnect			DAC P/N 1A84439-1	
E226	1	Valve, Check		W. M. Lanagan Co. P/N 90065	DAC P/N 7851843-1	
E227	1	Valve, Check		W. M. Lanagan Co. P/N 90065	DAC P/N 7851843-1	
E228	1	Filter		Aircraft Porous Media Co. P/N AC 4289-61	DAC P/N 7851840-1	
E229	1	Regulator, Pressure	3000 psig input press., 250 (± 25) psig output press.	B. H. Hadley P/N 11089-3	DAC P/N 7851841-501	
E230	1	Filter		Aircraft Porus Media Co. P/N AC4289-61	DAC P/N 7851840-1	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
E231	1	Valve, Relief		Sterner Engineering Co. P/N 20500	DAC P/N 7851842-1	
E232	1	Valve, Solenoid	NC	W. O. Leonard Inc. P/N 194100-3A	DAC P/N 7851845-505	
E233	1	Sphere, Storage	Helium, 3.5 cu ft at 3000 psig	Menasco Mfg Co.	DAC P/N 7851834-501	
E234	1	Sphere, Storage	Helium, 3.5 cu ft at 3000 psig	Menasco Mfg Co.	DAC P/N 7851834-501	
E235	1	Sphere, Storage	Helium, 3.5 cu ft at 3000 psig	Menasco Mfg Co.	DAC P/N 7851834-501	
E236	1	Valve, Electropneumatic	N. O.	W. O. Leonard Inc. P/N 194100-2A	DAC P/N 7851845-503	
E237	1	Switch, Pressure	Actuates at 320 (± 10) psia, deactuates at 115 (± 15) psia	Frebank Co. P/N 4940-1	DAC P/N 7871397-1	
E238	1	Valve, Electropneumatic	N. O.	W. O. Leonard Inc. P/N 194100-2A	DAC P/N 7851845-503	
E239	1	Orifice	0.250 in. dia		DAC P/N S5851838 -C8-250	
E240	1	Orifice	0.375 in. dia		DAC S4851838 D12-375	
E241	1	Heater Assembly			DAC P/N 5851759-503	
E242	1	Igniter		General Lab. Associates Inc. P/N 30104E	DAC P/N 7871525-501	

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
E243	1	Plenum Chamber		Tavco Inc. P/N 23711496	DAC P/N 1A21522	
E244	1	Igniter		Genral Lab. Associates Inc. P/N 30104E	DAC P/N 7871525-501	
E245	1	Switch, Pressure	Actuates at 2940 (± 25) psia, deactuates at 2840 (± 25) psia	Frebank Co. P/N 8008-1	DAC P/N 1A18676-1	
E246	1	Switch, Thermal	Actuates at + 110 (± 10)F	Giannini Controls Corp. P/N 49849	DAC P/N 1A65870-503	
E247 through E274 are not functionally applicable to this system.						
E275	1	Switch Differential Pressure	Actuates at 4 (± 1) psid, deactuates at 2 (± 1) psid	Frebank Co. P/N 4566-2	DAC P/N 7851831-1	
E276 through E279 are not functionally applicable to this system.						
E280	1	Switch, Pressure	Actuates at 52 (± 1) psia, deactuates at 50 (± 1) psia	Frebank Co. P/N 8015-6	DAC P/N 7851847-505	
E281	1	Switch, Pressure	Actuates at 44 (± 1) psia, deactuates at 42 (±1) psia	Frebank Co. P/N 8015-4	DAC P/N 7851847-501	
E282 is not functionally applicable to this system.						
E283	1	Switch, Pressure	Actuates at 47 (± 1) psia, deactuates at 45 (± 1) psia	Frebank Co. P/N 4586-1	DAC P/N 7851847-1	
E284 through E316 are not functionally applicable to this system.						

Finding Number	Reqd	Component	Remarks	Vendor	Drawing Number	Elec. Sym.
E317	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 223544-1	DAC P/N 7851827-501	
E318	1	Valve, Solenoid	3-way, 2-position, NC	Marotta Valve Corp. P/N 223544-1	DAC P/N 7851827-501	
E319	1	Valve, Solenoid	3-way, 2-position NC	Marotta Valve Corp. P/N 223544-1	DAC P/N 7851827-501	
E320	1	Valve, Solenoid	3-way, 2-position N. O.	Marotta Valve Corp. P/N 223544-1	DAC P/N 7851827-501	

Section 3

MECHANICAL SCHEMATICS

This section contains mechanical schematics that show the functional arrangement of LOX system components listed in section 2. For a definition of the mechanical symbols used, see MSFC-STD-162A.

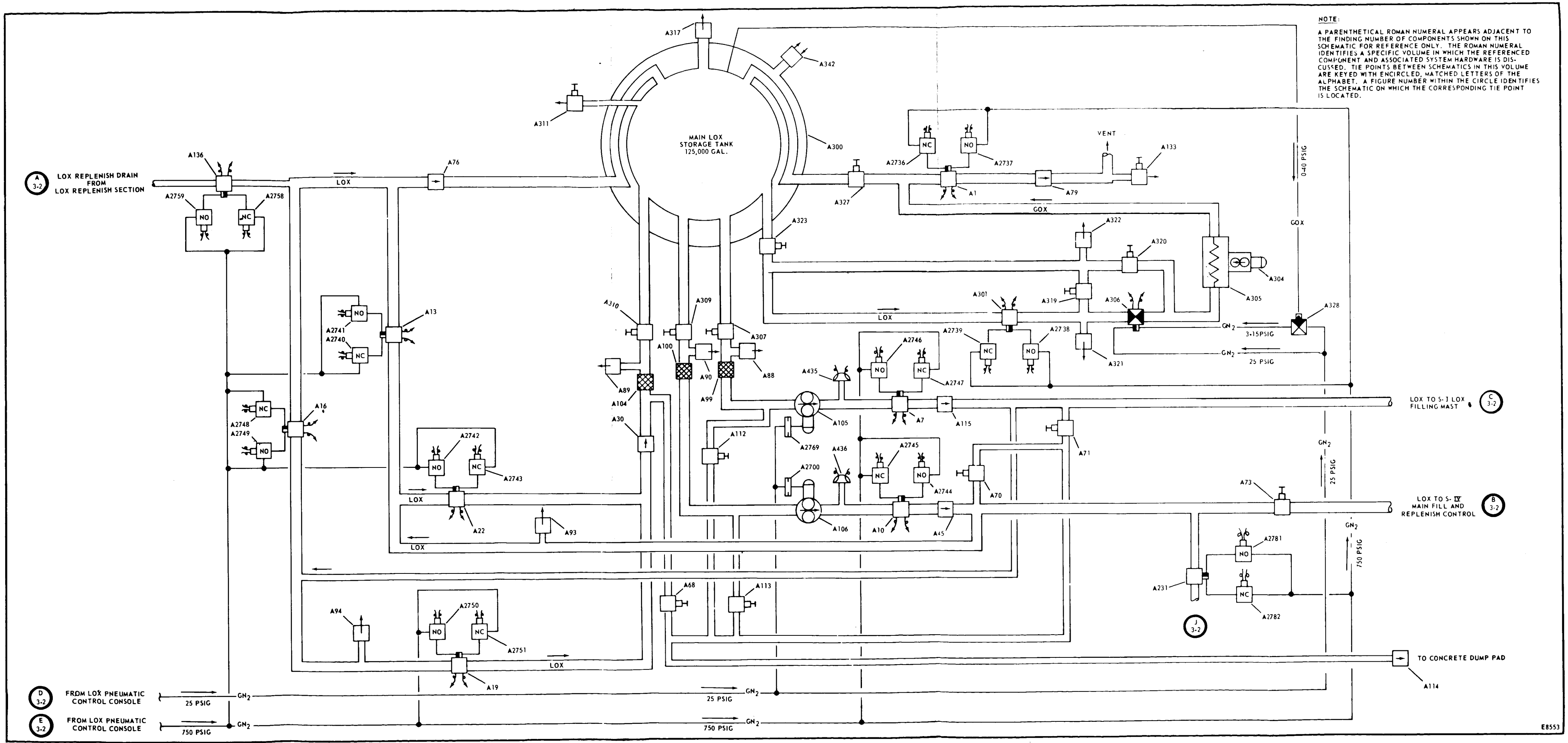

Figure 3-1. Launch Complex 37B Main LOX Storage and Transfer Equipment - Mechanical Schematic

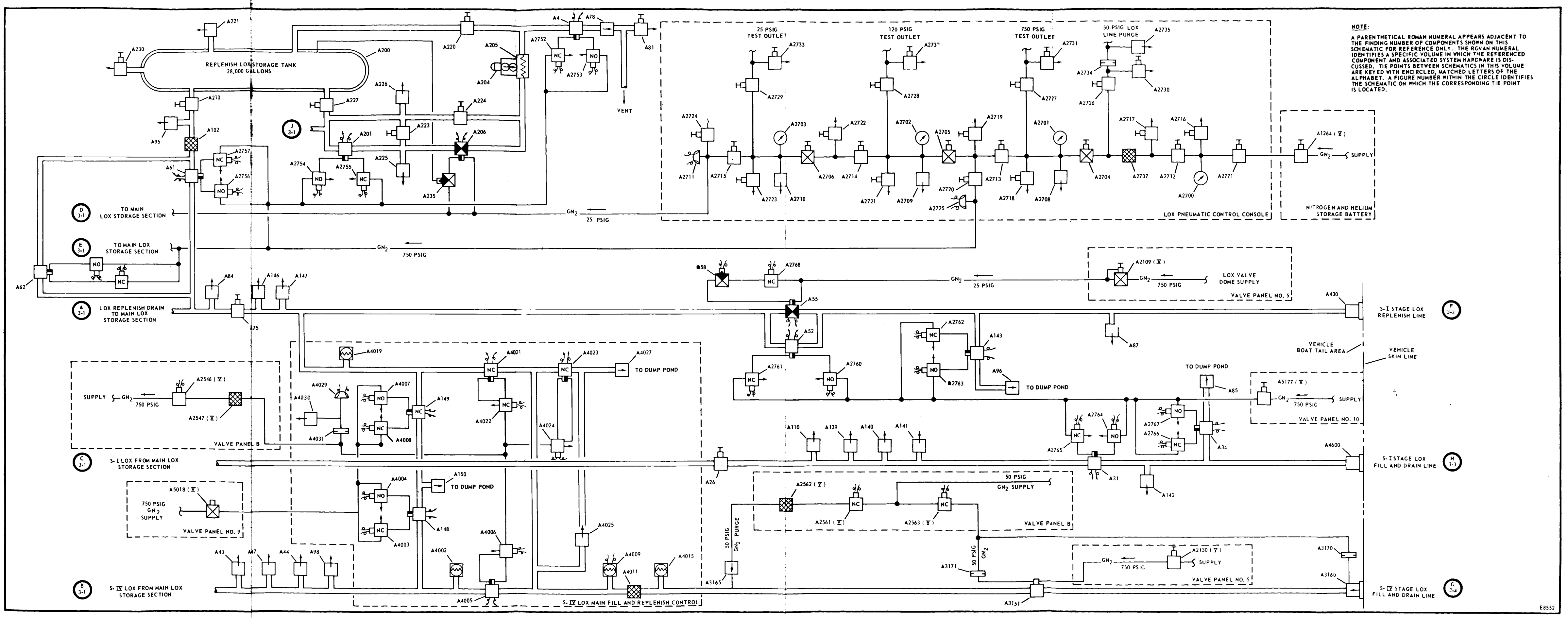

Figure 3-2. Launch Complex 37B Replenish LOX Storage and Transfer Equipment - Mechanical Schematic

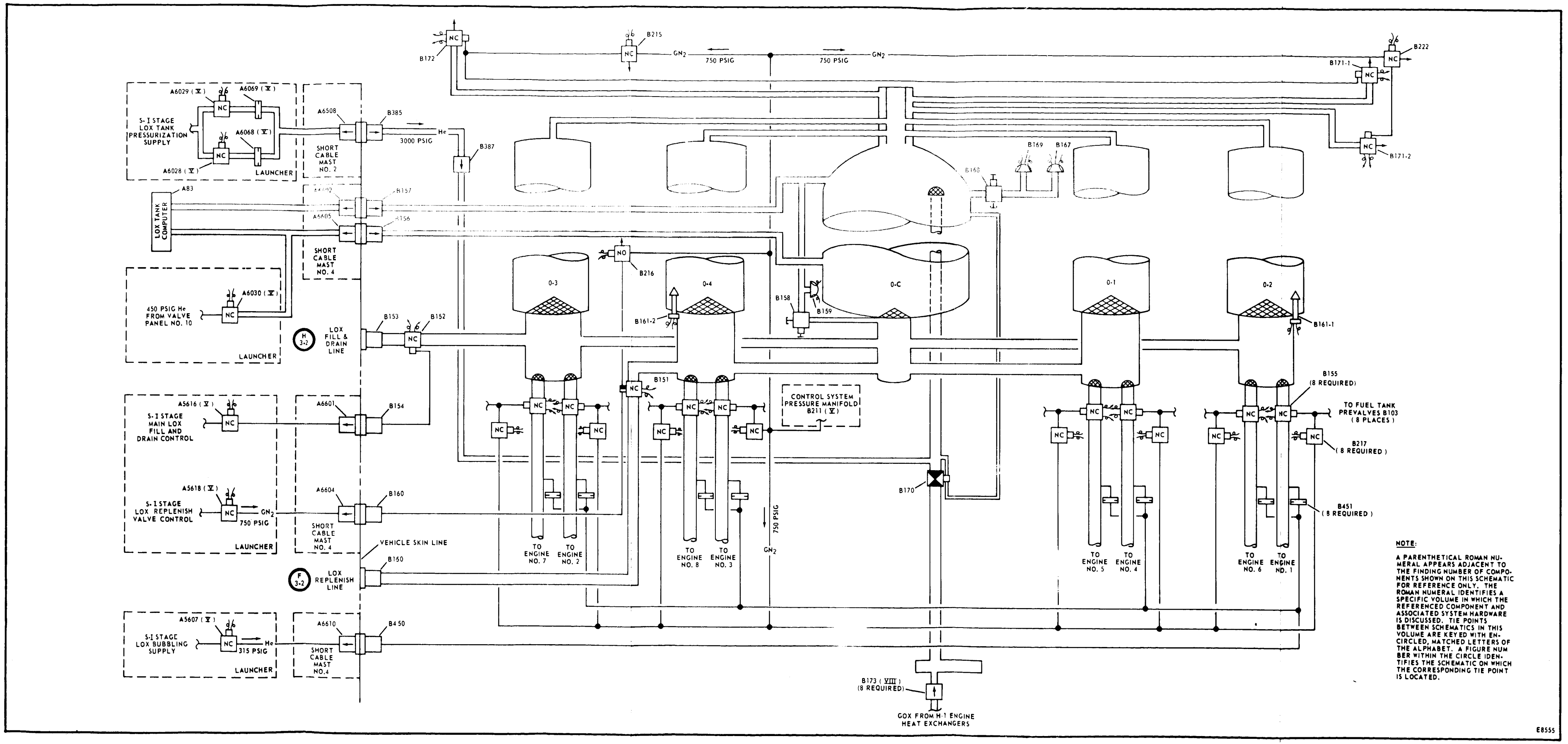

Figure 3-3. S-I Stage LOX System Components and Subsystems - Mechanical Schematic

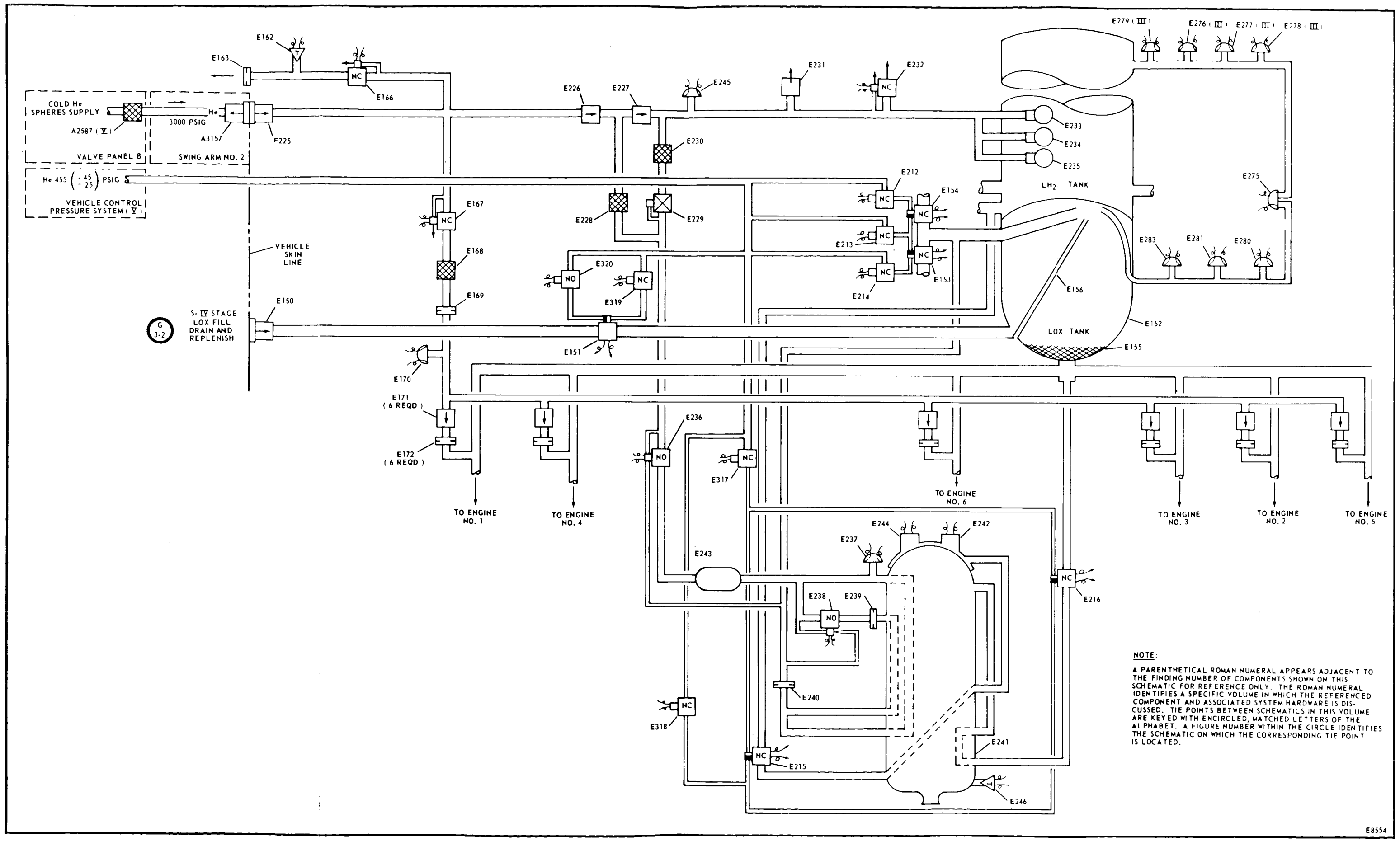

Figure 3-4. S-IV Stage LOX System Components and Subsystems - Mechanical Schematic